· JULY 1951 ·

Departments

ASME FALL MEETING—Minneapolis, Minn., September 25-28, 1951

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 For Editorial Contents See Page 541

DRAVO HEATERS..

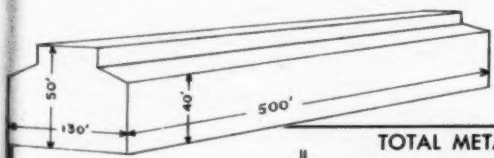
AS WELL AS MONEY....FUEL..

Heating system steel needs *can* be slashed from 50% to 70% for the representative open-space industrial structure shown below . . . by using the direct-fired warm air heating method with Dravo "Counterflo" Heaters! This conservation, of vital importance today, adds another to the long list of economies in money, fuel and labor effected by this heating method.

The chart below gives the detailed comparative story. Every system is equivalent in Btu output. Steel requirements for the 13 methods have been carefully and conservatively calculated.

It will be noted that Dravo Heaters not only take LESS steel in each fuel classification . . . but that the HIGHEST steel requirement in a Dravo installation is almost 50% less than the LOWEST steel requirement in any other system. Of special significance is the contrast in *pipe* required. Jobs now held up by slow pipe deliveries can MOVE . . . if Dravo Heaters are used!

Any time that YOUR jobs are delayed or deferred because of steel or pipe shortages, why not find out how Dravo "Counterflo" Heaters are expediting things for other users? And remember — steel savings are just *one* of the reasons that more and more Dravo "Counterflo" Heaters are heating increasing numbers and types of structures. You'll find many other good reasons listed at right, that will appeal to you.



Each heating system compared below was sized to make up a calculated 12,000,000 Btu heat loss in this representative industrial building.

TOTAL METAL REQUIREMENTS FOR VARIOUS HEATING SYSTEMS

COMPONENT	GAS FIRED					OIL	
	DRAVO WARM AIR	HIGH PRESSURE CONVENTIONAL BOILER	HIGH PRESSURE PACKAGED STEAM GENERATOR	LOW PRESSURE CONVENTIONAL BOILER	LOW PRESSURE PACKAGED STEAM GENERATOR	DRAVO WARM AIR	HIGH PRESSURE CONVENTIONAL BOILER
BASIC HEAT GENERATORS	26,400	38,000	62,000	38,000	62,000	26,400	38,000
PIPING—Oil—Steam Boiler Room—Gas	9,096	15,490	15,490	35,308	35,308	4,352	15,790
TANKS—Oil—Blow-off Condensate		3,500	1,500	1,500	1,500	13,000	16,500
UNIT HEATERS including Traps & Starters		21,240	21,240	21,240	21,240		21,240
STACKS & BREECHING	1,200	4,000	400	4,000	400	1,200	4,000
PUMPS—Fuel Oil Auxiliary Oil—Boiler Feed		1,000	1,000	1,000	1,000	400	1,400
STOKERS & FANS— including Dust Collectors Fuel Oil Preheaters							2,000
STRUCTURAL STEEL Boiler House Foundation Reinforcing		7,000	2,000	7,000			7,000
TONS of STEEL REQUIRED	DRAVO 18	45	52	54	61	DRAVO 23	53

..CONSERVE STEEL

.AND MAN HOURS

DISTRIBUTION PIPING AND DIFFUSERS COMPLETELY ELIMINATED

LEAST STEEL PER 1,000,000 BTU OUTPUT

NO VALVES, TRAPS OR FITTINGS

STAINLESS STEEL CHAMBER ELIMINATES REPLACEMENT

DRAVO CORPORATION

HEATING DEPT., DRAVO BUILDING, PITTSBURGH 22, PA.
Sales Representatives in Principal Cities.
Mfd. and Sold in Canada by Marine Industries, Ltd., Sorel, Quebec.

WITH IDENTICAL 12,000,000 Btu LOAD

FIRED →			← COAL FIRED ←		
HIGH PRESSURE PACKAGED STEAM GENERATOR	LOW PRESSURE CONVENTIONAL BOILER	LOW PRESSURE PACKAGED STEAM GENERATOR	DRAVO WARM AIR	HIGH PRESSURE CONVENTIONAL BOILER	LOW PRESSURE CONVENTIONAL BOILER
62,000	38,000	62,000	27,450	38,000	38,000
15,790	35,608	35,608		14,990	34,808
14,500	14,500	14,500		3,500	1,500
21,240	21,240	21,240		21,240	21,240
400	4,000	400	1,200	4,000	4,000
1,000	1,400	1,000		1,000	1,000
	2,000		23,850	15,000	15,000
2,000	7,000			7,000	7,000
58	**62**	**67**	DRAVO **26**	**52**	**61**

DRAVO HEATERS HAVE EARNED HIGHEST ACCEPTANCE BECAUSE THEY

- *use less steel*
- *eliminate distribution piping*
- *have lower initial cost*
- *are very efficient in fuel consumption*
- *concentrate comfort heat at the working level*
- *reduce roof heat losses*
- *burn gas or oil*
- *are available in coal burning models*
- *save man hours through automatic operation*
- *require no attendant and negligible maintenance*
- *produce heat instantly and ONLY when needed*
- *have stainless steel chambers for longer life*
- *prevent rust and stain conditions in metal storage*
- *bear UL label and AGA approval*
- *require only stack, fuel and power line*
- *are portable and readily moved*
- *provide year 'round ventilation*
- *are ideal for process drying*
- *avoid freeze up worries, leaky traps, valves, etc.*
- *are shipped complete and flame tested*
- *can be installed on floor, wall or roof*
- *can be mounted upside down or horizontally*
- *eliminate ductwork with 150 ft. air throw*

WRITE TODAY FOR BULLETIN HI— 23

You'll Want this New Folder About Better

GET your free copy of this useful new 6-page folder, now! It brings to you a picture-trip through the modern, daylight G.S. plant. Fifteen attractive halftone illustrations presenting a few of the many *different types* of G.S. Fractional Horsepower Gearing appear across the 3-page inside spread. Then, on the back page, you'll discover two useful standard charts. If the economical, mass production of better Small Gearing, from 12 to 96 D.P. is an important consideration in your business, then *by all means* send for this free folder now. Learn all about G.S. facilities, developed to their present high degree of perfection through more than 30 years of specializing in making Fractional Horsepower Gearing *exclusively!*

TEAR OUT..PASTE ON LETTERHEAD..AND MAIL TODAY! →

GEAR SPECIALTIES, INC.
2635 W. Medill Ave., Chicago 47, Ill.

Gentlemen: Please send me at once, a free copy of your new 6-page folder about G.S. Fractional Horsepower Gearing.

NAME ____________________

ADDRESS ____________________

BUYER'S NAME ____________________

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GEAR Specialties, Inc.

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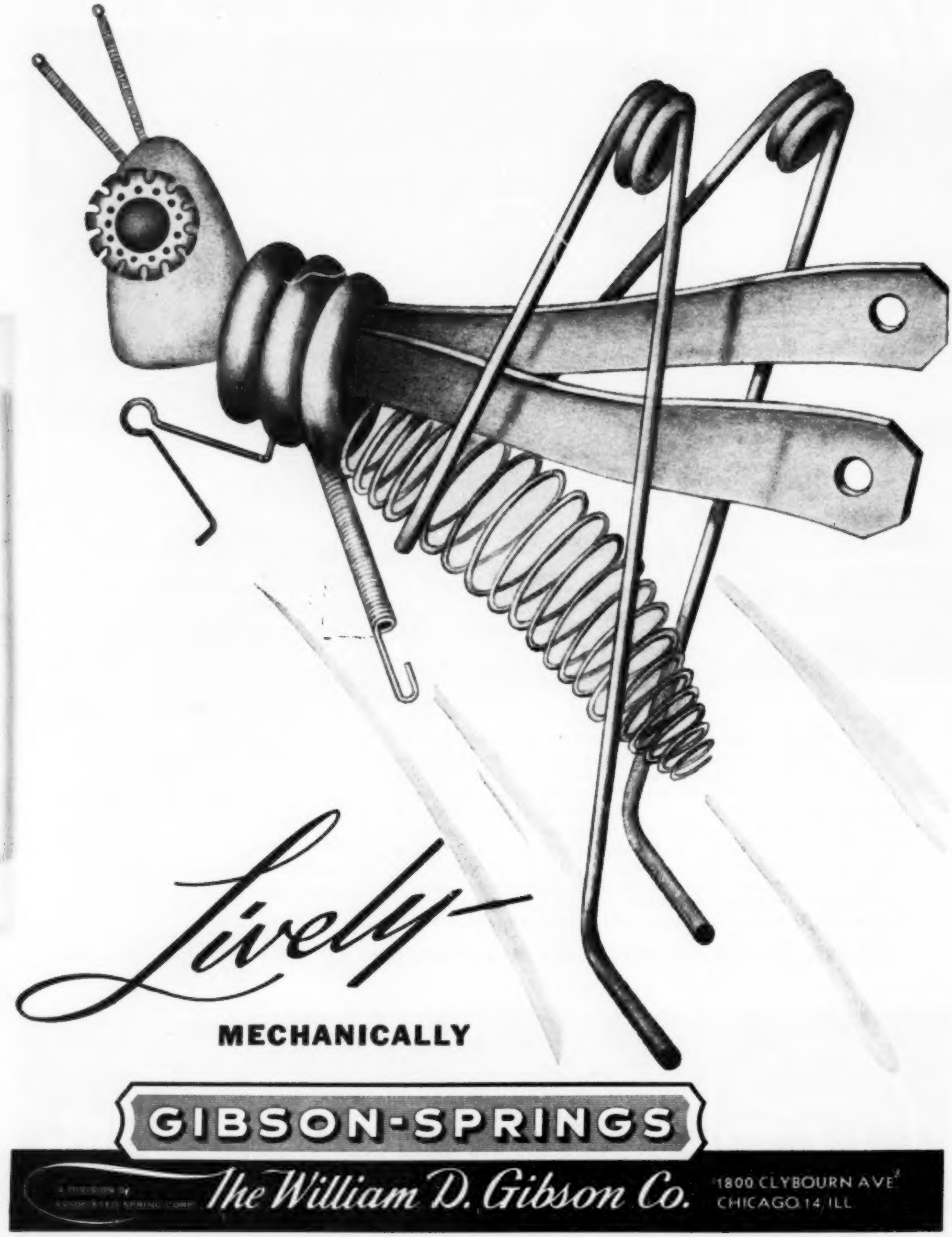
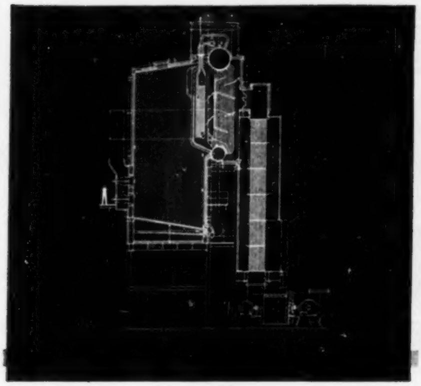
MEMBER OF

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

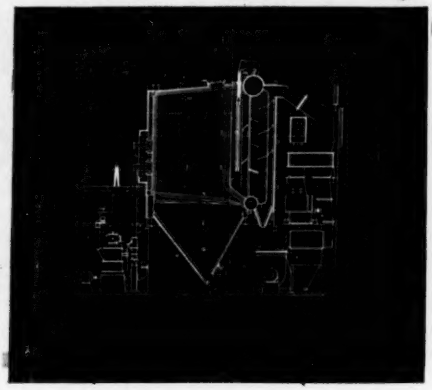

Lively—
MECHANICALLY
GIBSON-SPRINGS
The William D. Gibson Co.
1800 CLYBOURN AVE
CHICAGO 14, ILL.

ONE VU LEADS TO ANOTHER

VU-10 Unit fired with C-E Spreader Stoker (dumping grate type). VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hr. May also be fired by underfeed or traveling grate stokers, or by oil or gas.



VU-50 Unit fired with natural gas or oil. Design provides for future pulverized coal firing. Capacity of unit shown is 350,000 lb of steam per hr; operating press.—920 psi; steam temp.—905F.



VU-50 Unit fired with pulverized coal using C-E Raymond Bowl Mills. The capacity of unit shown is 150,000 lb of steam per hr; operating pressure—600 psi; steam temperature—700F.

When VU Boilers were first put on the market, *all* of them, quite naturally, had to be *sold*. Now a very substantial percentage are *bought*. Bought by companies that know by their own first-hand experience what they can expect in day-in and day-out performance—for example:

A paper company some years ago, in urgent need of more capacity, purchased a VU Unit. It went on the line, and—under wartime demand—*stayed there* for 432 days without a shutdown. What do you think they bought when next in the market in 1946? That's right . . . another VU (much bigger than the first).

An automobile company installed its first VU Units (2) in 1947. Two more were ordered for another of its plants in 1948; then three more units for a third plant in 1949 and two more for still another plant in 1950.

A refinery ordered its first VU Unit in 1937. In 1941 another was installed and still another in 1950. For another of its plants two units were ordered in 1942 and a third in 1947.

An electric utility company installed its first VU Unit in 1941. Two more units were ordered for another of its plants in 1947, a unit for a third plant in 1946 and still another for a fourth station in 1949.

* * *

And so it goes—in all sections of the country—and abroad—industry after industry ordering and *reordering* VU Boilers. There must be a reason—and there is. The VU's advanced design, rugged construction and consistent reliability have become a service-proved answer to lower steam costs. You can choose VU with confidence based on the experience of companies in *your* industry, in *your* area.

B-485A

C·E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

Combustion Engineering Building

200 Madison Avenue • New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Prolong the life of your bearings

Model 53—An efficient, general purpose seal for high speeds. For shafts 3" to 10" diameter.

PATENTED

Use Garlock KLOZURE* Oil Seals

SERVICE records from thousands of different installations prove that bearings *last longer* and require *less maintenance* when they're protected by Garlock KLOZURE Oil Seals. Once a Garlock KLOZURE has been installed, you have the best possible insurance that the bearing lubricant will be sealed *in*—that dirt and foreign matter will be locked *out*.

There's a service-tested KLOZURE design for practically every bearing application. These superior oil seals are produced in a wide range of sizes including Metric O. D. to fit bearing manufacturers' standard bores. A few of the most widely used models are shown here.

Write today for the new Klozure Catalog

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

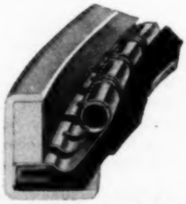
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

GARLOCK *Klozure** OIL SEAL

*REG. U. S. PAT. OFF.

Model 51—A sturdy seal for medium speeds. May be used on reciprocating rods and against moderate pressures.

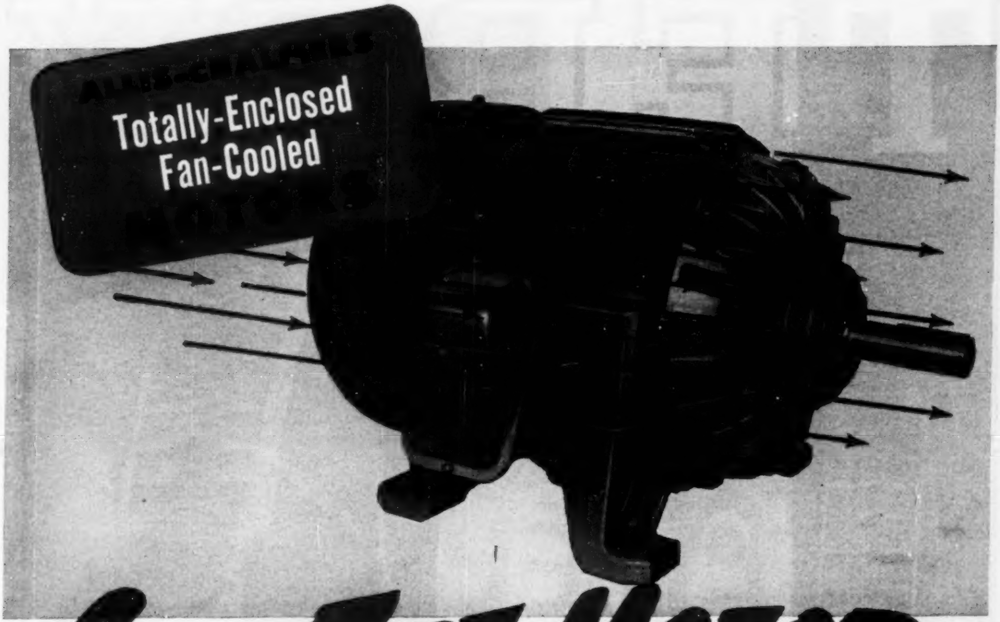
Model 63—An efficient, general purpose seal for high speeds. For shafts 3" diameter and smaller.



Model 64—A strong, effective seal for heavy duty on shafts of the largest diameter.

Model 91A—A springless seal of small cross section, with the metal reinforcing member surrounded by rubber.

Model 91B—A springloaded seal of small cross section, with the metal reinforcing member surrounded by rubber.



USE THE MOTOR that Cleans Itself

YOU CAN CUT DOWN on motor cleaning operations and greatly reduce inspections and overhauls on the equipment you design. Tests have proved that on most applications totally-enclosed, fan-cooled motors more than pay back their extra cost in reduced maintenance. And this new Allis-Chalmers Type APZ tefc motor makes maintenance costs lower than ever before on this type of motor.

Here's Why

Concealed air passages and pockets have been eliminated; dirt cannot build up to cause overheating. Cooling air is blown over the ribbed cast iron frame and bearing housings carrying dirt away with it. How about oily dirt that sticks? It can be wiped or blown off without stopping the motor.

Rigid Construction

The frame is rigid cast iron which not only has high inherent corrosion resistance, but also holds bearings permanently in alignment. Bearings are prelubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

The new Allis-Chalmers Type APZ totally-enclosed, fan-cooled motor is built in all NEMA standard frame sizes from *224 to 505. Also in explosion-proof type. Your A-C Authorized Dealer or District Office offers you competent engineering aid on your design problems. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B6144.

A-3402

Sold . . . Applied . . . Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

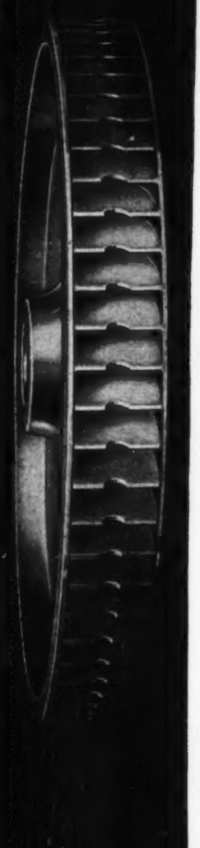
PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

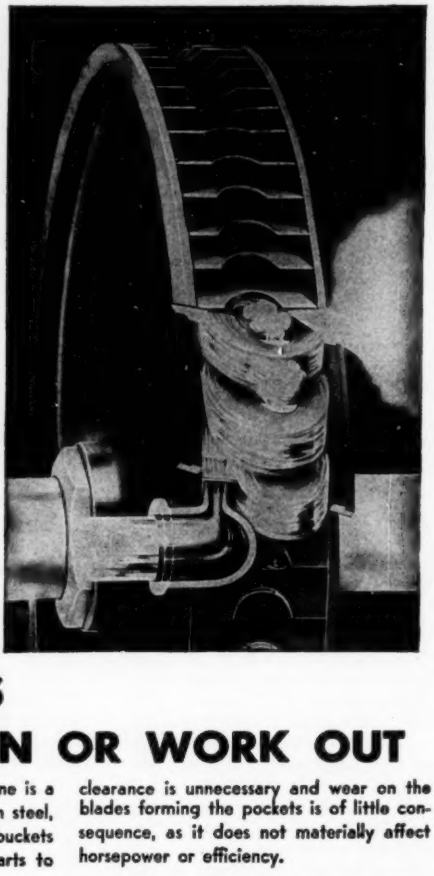
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS A-C

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

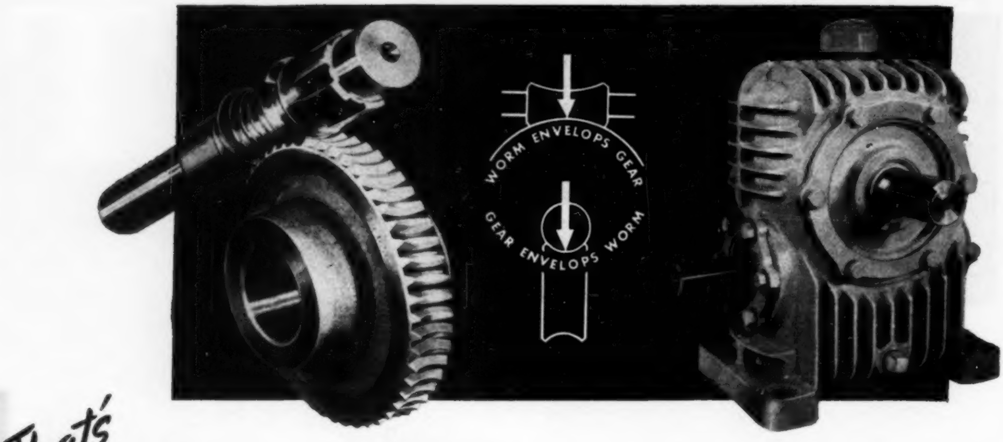
The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



That's right—"hydraulically smooth" gears!

What we mean by "hydraulically smooth"

It used to be thought that carbide-tipped milling cutters on milling machines had to be protected against carbide-damaging gear vibrations in the cutter drive by using large flywheels at the cutter head. When Cone-Drive double-enveloping gears were tried, their 'hydraulic smoothness' made the flywheels unnecessary.

Never heard of gears that are hydraulically smooth? Then you should try Cone-Drive DOUBLE-ENVELOPING gearing: In Cone-Drive gears, the pinion or worm is wrapped around the gear and the gear is wrapped around the worm in such a manner that

regardless of number of teeth, gear size or ratio, ⅛ of all gear teeth are in CONTINUOUS CONTACT

What is more, they are in continuous FULL DEPTH area contact. As a result, not only is power transmitted in a smooth uninterrupted flow AROUND THE CIRCUMFERENCE of the enveloped gear, but the load capacity for a gear set of any given center distance is greatly increased.

That means longer, trouble-free service, and the ability to use smaller gears to transmit a given load. As a matter of fact, Cone-Drive double-enveloping gears are so compact that many designers find they can simply

replace costly built-in gear trains with complete standardized Cone-Drive speed reducers

If you are looking for gears or reducers that will give you real hydraulic smoothness, greater load carrying capacity in a limited space, and a simpler gearing installation, fill in the coupon, attach to your company letterhead and mail it today.

CONE-DRIVE GEARS
DIVISION OF MICHIGAN TOOL CO.
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Detroit 12, Mich.

Please send me without obligation further information on double-enveloping Cone-Drive Gears. We are particularly interested in the following:

Horsepower_____to_____

Ratio ____/1 to ____/1

Name____________________

Title____________________

(attach to company letterhead and mail)

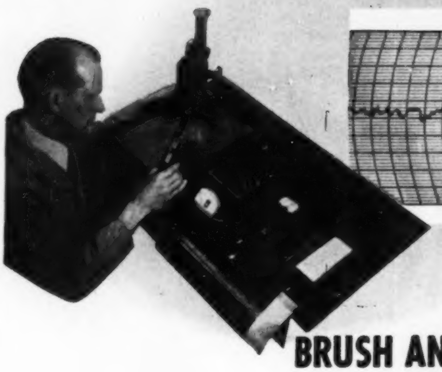
CONE-DRIVE GEARS

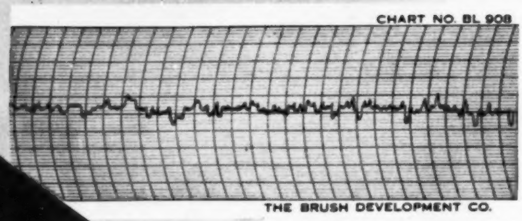
Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

How good is the surface?





Profile chart of test surface gives positive, numerical answer to smoothness questions. Distance between each horizontal line on chart represents one micro-inch.

BRUSH ANALYZER GIVES YOU COMPLETE DATA

... in writing

• With the Brush Surface Analyzer* you can obtain not only numerical evaluation of surface smoothness, but also a highly magnified profile of the surface in chart form—enlarged beyond the range of optical microscopes. Variations of less than 1/1,000,000 of an inch are readily apparent, and can be measured on the calibrated chart.

To check any surface—metal, glass, plastic, paper, etc.—the Analyzer probes the surface with a Brush crystal pickup. A "hill and dale" chart is drawn by the recorder, and the average finish is also indicated on a large illuminated scale.

The Brush Surface Analyzer eliminates guesswork in specifying and checking finishes. Exact numerical values can be specified and verified. Where desired, customers can be provided with a permanent record of inspection results.

If you manufacture or use precision parts, find out how you can benefit from the accurate measurements made possible by Brush Surface Analyzers. And investigate other Brush Analyzers for studies of a-c or d-c voltages or currents, strains, displacements, light intensities, temperatures, and other static or dynamic conditions.

Write for information. The Brush Development Company, Department P-10, 3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A. *Canadian Representatives:* A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14, Ontario.

*Trade Mark Registered in U. S. Pat. Off.

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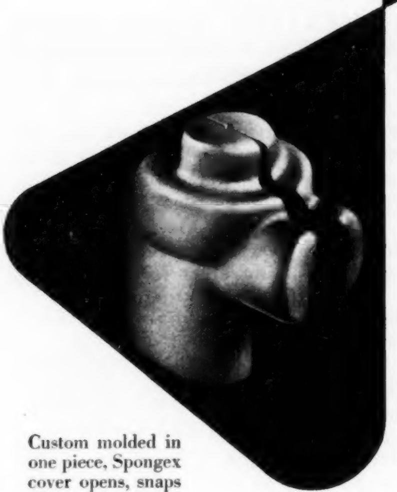
PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING
ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

SPONGEX®

cellular rubber

Prevents Frosting And Sweating

"A-P Valve Insulator courtesy of A-P Controls Corporation, Milwaukee, Wisconsin."



Custom molded in one piece, Spongex cover opens, snaps closed around valve.

When this expansion valve is installed outside of low temperature apparatus a custom molded *Spongex* insulator prevents dripping which otherwise would damage the floor or equipment beneath. Besides its special shape the requirements of this part called for cellular rubber of interconnecting cell structure with natural skin on all exposed surfaces.

For many manufacturers, conversion is bringing new and different requirements for materials. Your needs in cellular rubber might call for **SPONGEX** similarly molded. Or a die-cut shape. Or a standard cord, tube, strip or sheet. Perhaps you seek the 0.28-0.30 K insulating factor of **SPONGEX CELL-TITE®** or the efficiency of **SILICONE SPONGEX** at –100° F to 450° F Spongex stands ready to help you solve any problems you may have.

This new booklet on the properties of, test data on, and specifications for cellular rubber has just been released. It's concise, and a valuable reference source. Write for a free copy today.

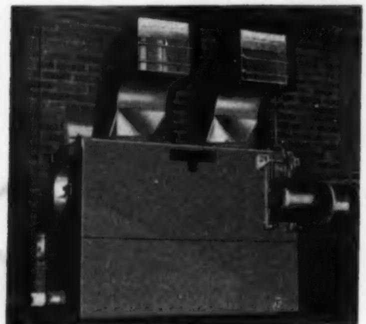
The World's Largest Specialists in Cellular Rubber.

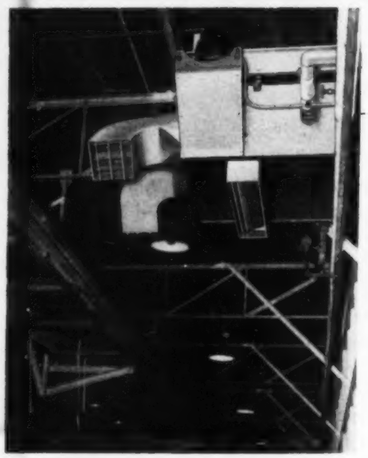
THE SPONGE RUBBER PRODUCTS COMPANY

401 DERBY PLACE — SHELTON, CONNECTICUT

HEAT WHERE IT'S NEEDED!

with "Buffalo" UNIT HEATERS





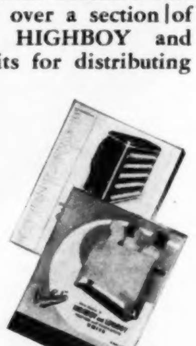
SUSPENDED—OUT OF THE WAY!

"Buffalo" LOWBOY heaters take no floor space. Unit has efficient "Buffalo" fan for positive heat throw, and can be used for straight ventilation in warm weather. LOWBOY heaters are also used to supply make up air in plants, mills and foundries where exhausters are used extensively.

PLAN NOW FOR NEXT WINTER

QUALITY-BUILT HEATING, VENTILATING AND FRESH AIR UNITS—A RIGHT MODEL FOR EVERY TYPE OF INSTALLATION

Getting the heat to the worker, or to the working area can sometimes be a problem—but not with the complete range of models in the "Buffalo" Unit Heater line. This line includes everything from the efficient BREEZO-FIN heaters which can throw heat down over a section of benches or machines—to the big HIGHBOY and LOWBOY heating and ventilating units for distributing heat over large areas. LOWBOYS can be mounted on walls or ceilings, without using up productive or storage space. The narrow HIGHBOYS are economically installed on floors next to walls, where they require little space. *For complete information, write for free Bulletin 3137-D and 3704-A.*



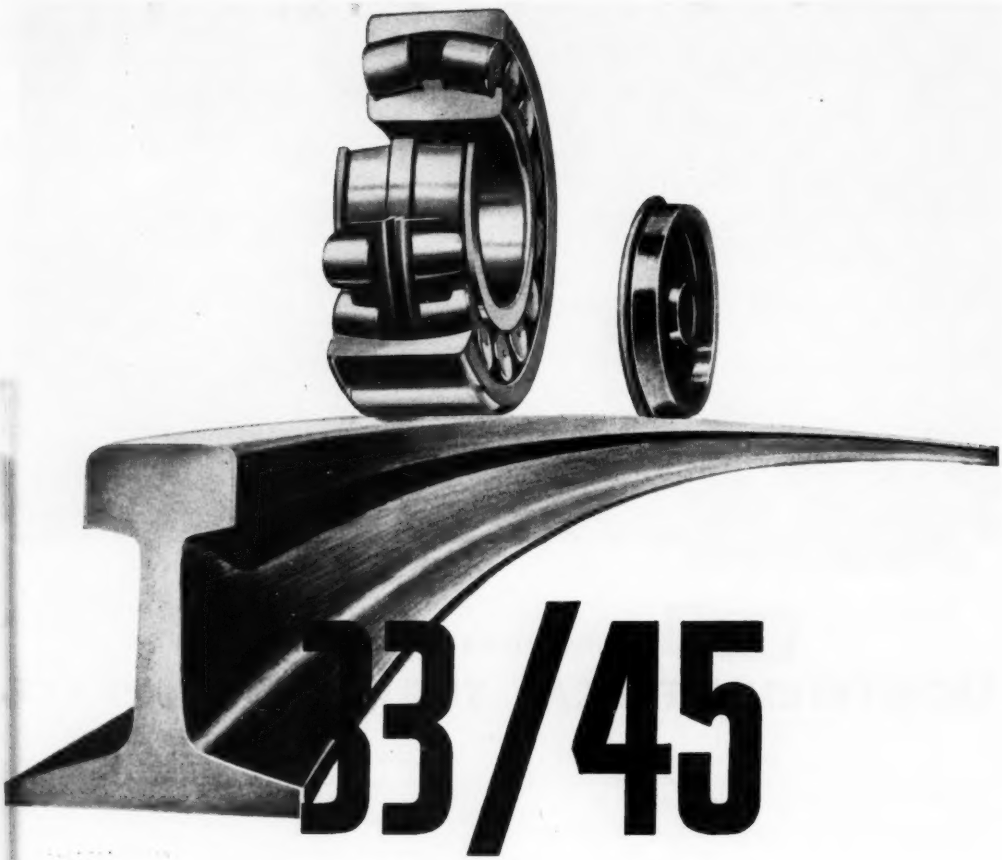
"Buffalo" FIRST FOR FANS

BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Branch offices in all Principal Cities

VENTILATING · AIR WASHING · AIR TEMPERING · INDUCED DRAFT · EXHAUSTING
FORCED DRAFT · COOLING · HEATING · PRESSURE BLOWING


33/45

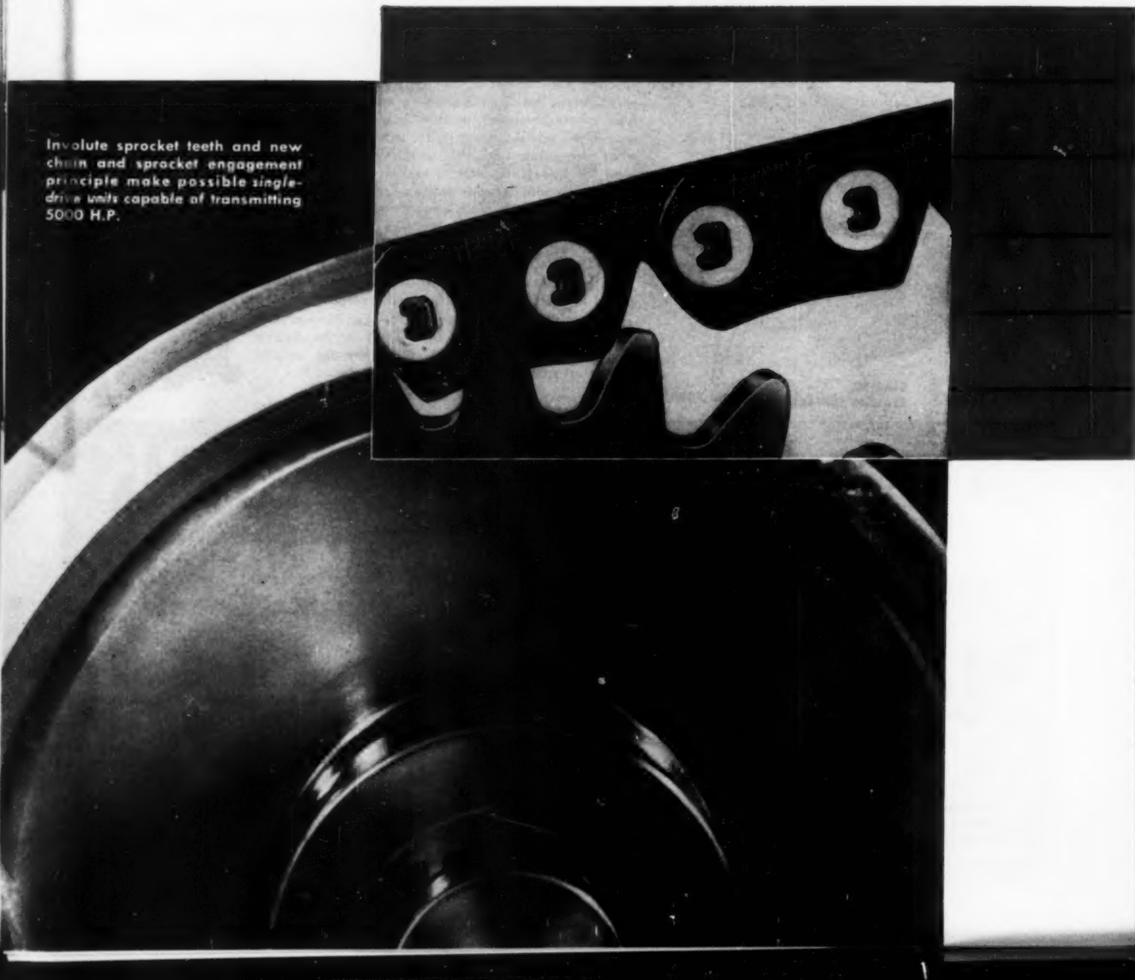
Now—
more than ever

M=PT

Money means
Power
Transmission

Sensational, new transmits more speeds than any

Involute sprocket teeth and new chain and sprocket engagement principle make possible *single-drive units* capable of transmitting 5000 H.P.



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VOLUME 73 NUMBER 7

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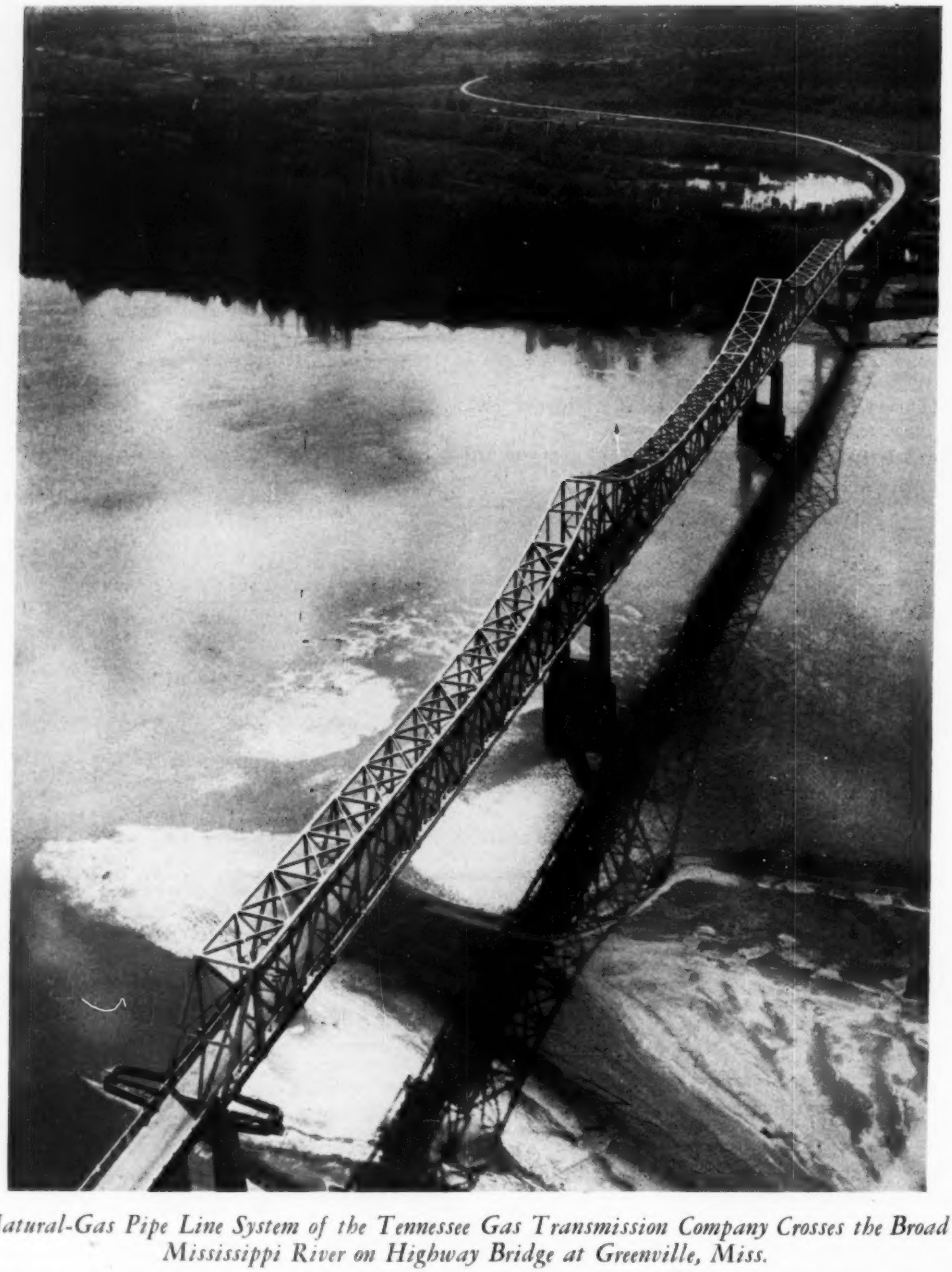


Natural-Gas Pipe Line System of the Tennessee Gas Transmission Company Crosses the Broad Mississippi River on Highway Bridge at Greenville, Miss.

(Four steel pipe lines, each 26 in. in diam., are attached to the sides of the bridge. They transport more than one billion cu ft of natural gas daily across the river. *See pages 545–548.)*

VOLUME 73
No. 7

MECHANICAL ENGINEERING

JULY
1951

GEORGE A. STETSON, *Editor*

Publication Responsibilities

IN an article that appeared in our June issue, R. E. Peterson quoted a three-point policy in respect to the professional development of graduate engineers that has been established by a large manufacturing company. This policy was stated as follows:

1 Active participation in engineering societies by every qualified employer should be encouraged; such participation should be regarded as part of the man's normal and regular work.

2 A good engineering development job is not finished until the noteworthy engineering uncovered has been presented at the proper time before a national technical society, and the pioneering knowledge of the company is made part of the permanent engineering literature.

3 Membership in at least one engineering society is a definite responsibility of any employee who regards himself as a member of the engineering profession.

Attention is here directed to the second of the three points of the policy quoted—the obligation to add to the permanent engineering literature. This obligation begets another which bears heavily on engineering societies. It is recognized by The American Society of Mechanical Engineers in the statement of Society objectives in the By-laws—"publishing papers and reports and disseminating knowledge and experience of value to engineers."

In our June issue, J. Calvin Brown, president ASME, described briefly for the benefit of members, the processing of ASME papers; and in this current issue he gives a partial reply to the question, why are some papers not published? This is a natural and a fair question; and in the light of Mr. Peterson's policy statement and the ASME objective just quoted, it certainly demands serious consideration.

The larger problem of publication of technical papers is twofold, as was pointed out in these pages in June. First, there is the problem of discovering, reviewing, and selecting the papers that are presented at Society meetings. Second, there is the problem of selecting from this group of papers those that are to be printed and hence are destined to become part of the permanent engineering literature. Each paper faces two critical tests of its value: Shall it be presented at a meeting? Shall it be printed? The forty-odd program-making groups of the Society make the first of these critical decisions; the Publications Committee makes the second in the light of recommendations based on reviewers' comments.

How well does ASME meet the objective stated in its By-Laws? If the engineer employed by a progressive company which has adopted a policy of encouraging contributions to the permanent technical literature has done his part by preparing a paper, does the Society do its part by publishing that paper? Answers to these questions will vary because personal experiences and judgments vary. Mr. Brown points out in his current message to the members that the ASME editorial department receives annually about 400 papers from all sources, that 250 of these are printed in full in the Society's periodical publications, and that a dozen more are printed in condensed form. Digests of about 300 papers available for purchase in preprint form (here are many overlaps with the 250 printed) appear in this magazine. These figures are one measure of performance that will satisfy some persons. They will evoke the question, Why were not all papers published? in the minds of other persons, to which Mr. Brown has suggested some of the reasons in his message. They will cause still other persons to wonder if the percentage of published papers is higher than the criterion of permanent value can justify. What but careful review and selection can safeguard publications on this point?

Practically every scientific and technical society faces not only the problem of determining which of the papers offered to it are worthy of publication but also the problem of meeting high printing and distribution costs. Each of these problems places burdens on members. In ASME, for example, value judgments have to be made by committees of members and by reviewers, all of whom serve without pay. Knowledge of specialized fields, competence to form sound judgments, and devotion to the engineering profession are required of men who bear the burden of selection. The expense of publication is met by members' dues, but in the case of ASME this expense is nearly offset by advertising and publication sales income. No balancing of financial accounts, however, justifies waste in publication of mediocre papers. And free distribution, which in the case of ASME Transactions practically doubles publication expense, has forced an increasing number of societies, including ASME, to place certain publications on a subscription basis. Since quality and publication expense become two important considerations in the selection of papers for publication, much study must be given to each.

If ASME is to progress and provide an outlet for publication of papers, thus affording its members the opportunity of discharging their obligations as professional men, it will find that the task of selecting papers for publication and of meeting the expense will continu-

ously increase. Improvements in the selection process and mounting publication expense will lay even greater burdens on members. No one who has followed the development of ASME will doubt that the improvements will be made or the expense met. One has only to look back over the last quarter century and then to project experiences and trends into the next to realize how crucial these problems are likely to become.

The art of engineering is being leavened with the ferment of science. Science follows practice and eventually establishes new practices. The accumulation of scientific knowledge is growing at so rapid a rate that significant changes in mechanical engineering are inevitable. The need for papers to keep mechanical engineers up to date, the pressure of papers by engineers working in these outposts of progress, the quantity and quality of highly specialized knowledge necessary properly to review and select the papers received and to organize programs for presentation and discussion are bound to grow. This growth will place on the Society the difficult task of finding the men who can serve on its committees and review its papers. It will make the task of selection more arduous. It will increase the volume and expense of publication. But it will also provide an opportunity for the Society to work significantly for the benefit of mechanical engineers and the development of mechanical engineering.

For present and future generations of engineers, as well as for the ASME, there are tasks of service to one another and to the nation which call for aggressive leadership, for keen intelligence and for courageous and imaginative action in planning and discharging projects in the further development of the engineering profession. A sound and vigorous policy in respect to technical publications that will make available to mechanical engineers the advances in science and the developments of engineering research laboratories, and contemporary practice must continue to advance toward this end. Only thus can the original work of engineers find a useful outlet and permanent record. Only thus can ASME discharge the obligation it set for itself in the By-Laws. The men to administer the policy will appear as need arises. The cost in dollars will be met by the desire of members to advance the profession to which their lives are devoted.

Industrial Internship

EVERYBODY is familiar with those bright-faced white-clad youngsters with stethoscopes hanging about their necks, trooping down hospital corridors after the house surgeon, slipping quietly and confidently from ward to ward to look in on patients, smoking cigarettes and drinking coffee in the cafeteria, or chatting with attractive nurses in dim and hushed alcoves—competent fellows, serious-minded and yet lighthearted—the interns. Everybody knows that they have spent the best years of their lives in college and medical school and have invested thousands of dollars—much of it borrowed, perhaps—on an education. And everybody realizes that one day soon they will be on their own, building up a practice, serving humanity, saving lives, instilling hope and confidence in the minds of anxious parents, bolstering the health and happiness of a community, and easing the pain and weariness of old age. Everybody knows them, blesses them for dedicating their lives to the service of their fellow men, and rejoices that the opportunity of internship is theirs—those few months in which they put theory into practice under skilled guidance, acquire firsthand knowledge of human ailments, perfect techniques in healing arts and preventive measures, are imbued with the importance and seriousness of their profession, and gradually fit themselves for the responsibilities to be laid upon them.

But who knows the interns of the engineering profession—except the engineers? To a large portion of the public they are college boys with crew haircuts and adolescent notions about the world; the overprivileged and the overpaid. They have had advantages "my boy" never had. They are the friends and associates of the management. Someday they will be the "top brass."

Here are two divergent (and possibly exaggerated) views of young men who are dedicating their lives to the professions—the medical and engineering.

In an attempt to disseminate a better understanding of the importance of the engineering graduate, the Engineering Manpower Commission of the Engineers Joint Council has issued a newsletter devoted to "Industrial Internship—A National Necessity."

"Few engineering graduates," reads the newsletter, "enter employment that makes them important and irreplaceable immediately after graduation. Most must undergo a period of further training to make them useful engineers. This training blends the education they received in the fundamentals of science and engineering with the specific design and production needs of the company employing them. This is just as important in the engineering profession as the period of internship in some other professions.

"Engineering graduates," the statement continues, "when employed by industry, are true assets only if they are properly trained in and integrated with that particular branch of industry in which they are employed. Many industrial organizations have well-planned high-level training courses lasting several months to a year or two. These courses are essential to the maintenance of the industrial might of the nation.

"The Armed Services need ships, planes, tanks, guns, trucks, radio, sonar, and other modern devices of war," it is stated. "These are the result of research, development, design, and other engineering applications by industry. Our survival depends on even better invention, developments and production of equipment, goods, and services. Industry cannot accomplish this if it cannot retain and train its professional technical manpower or if it cannot depend upon its only source of recruits—graduate engineers."

When we consider that the deficit of engineers will be at least 60,000 in 1955, we can see how important it is to maintain industrial internship at a high level. Industrial internship is a national necessity.

Long-Distance NATURAL-GAS-TRANSMISSION PIPE LINES

By J. J. KING

CHIEF ENGINEER, TENNESSEE GAS TRANSMISSION COMPANY, HOUSTON, TEXAS. MEMBER ASME

IN 1925 there was constructed in the Southwest the first all-welded large-diameter natural-gas-transmission pipe line in this country. Designed to operate at a pressure of 500 lb with a safety factor of about 3, the line was built using lap-welded pipe and acetylene-welded joints. This pipe was of 14, 16, 18, and 20 in. diam, with the size increasing progressively from each compressor station and ending with 20 in. diam on the intake side of each pumping plant.

At that time there were relatively few mechanics in the Southwest capable of turning out consistently good welds, and the best welding rod available produced a joint generally weaker than the pipe material itself. In order to speed up the construction of this pipe line, a line about 200 miles long, schools were set up at several locations along the pipe-line route for training welders. The best welders available were used as instructors and about 100 pipe-line welders qualified within a few weeks.

This line was completed in record time and put into service in late fall with many old-time pipe liners predicting that it would not hold together. To some extent, their beliefs were substantiated. When ground temperatures began to drop, failures in welds occurred at a number of points. Failures continued spasmodically all through the first winter although no interruption of service was experienced due to the use of specially designed leak clamps which could be installed under pressure. It is worthy of mention that no expansion joints as such were provided for in this pipe line. An extra-wide ditch was dug and slack left in the line when it was lowered into the ditch—a practice followed today in welded pipe-line construction.

That this method of building welded pipe lines was sound is evidenced by the nature of the breaks experienced in that first line. In almost every case the failure consisted of a crack in the welded joint which seldom extended more than halfway round the pipe, with a maximum opening of perhaps $^{1}/_{16}$ in. Such breaks were repaired easily with the special leak clamps without shutting down the line. Bellows-type expansion joints spaced about 150 ft apart were later used in some electric-welded pipe lines. This practice, however, was abandoned because of its expense, and experience with pipe lines without expansion joints indicated no need for such a device.

MACHINES DO A GREAT DEAL OF HARD PIPE-LINING LABOR ONCE DONE BY MEN, BUT THERE STILL REMAINS MANY A MUSCLE-STRAINING JOB WHICH IS FOR MEN ONLY

(Here Tennessee Gas Transmission Company's line was being extended in 1950 north of Portsmouth, Ohio.)

PRESENT PRACTICE

Present-day gas pipe-line design and construction is vastly different from that of 20 or 25 years ago. Operating pressures have increased to where 700 to 1000 lb is now common practice. Pipe diameters now range up to 30 and 34 in. where 22 in. was the largest-diameter long-distance all-welded natural-gas pipe line as late as 1927. For many years electric welding for joining the pipe has been substituted for acetylene welding. Lap-welded pipe has been replaced by seamless tubing in many applications, and electric-welded pipe made from high-yield-point steel plate is almost universally used for large-diameter lines. Large-diameter pipe is now commonly available in 30- and 40-ft lengths, and on many pipe-line jobs an operation called double-jointing is carried out before the pipe is strung along the right of way. This operation consists of welding together two 30 or 40-ft joints of pipe by means of an automatic welding machine, thereby reducing the number of welds to be made in the field after the pipe is strung. Yield points in excess of 52,000 psi for the finished pipe are now commonly available. Advanced methods for coating and wrapping pipe, and the application of cathodic protection to pipe lines have permitted the use of thinner-wall pipe than used earlier when not too much attention was given to protecting pipe adequately against corrosion.

The use of mechanical equipment for cleaning, priming, coating, and wrapping large-diameter-pipe lines after the pipe is welded allows this operation to be carried out as the pipe is

Presented at a meeting, Buffalo, N. Y., February 6, 1951, of the Buffalo Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

WELDERS AT WORK ON A SECTION OF 26-INCH LOOP LINE LAID DURING 1950 FOR TENNESSEE GAS TRANSMISSION COMPANY ON KING RANCH, NATION'S LARGEST CATTLE RANCH, LOCATED IN SOUTH TEXAS

lowered into the ditch. This procedure provides a more uniform coating job, and use of the "holiday detector," an electrical device for detecting breaks in the coating which are not visible because of the wrapping material on the pipe, is an additional measure taken to provide an adequately coated pipe line. The practice of x-raying a certain percentage of the joints made in the field is now generally followed on large-diameter-pipe lines. Immediate developing of the x-ray film on the job allows a thorough inspection of the quality of the welded joint before the pipe is coated and wrapped and put in the ditch.

CHARACTERISTICS OF LARGE-DIAMETER PIPE

In connection with the characteristics of large-diameter pipe now generally used in natural-gas transmission lines, it may be of interest to cite some of the chemical and physical properties of the steel plate used in making pipe. Typical minimum physical properties of plate material are given in Table 1.

TABLE 1 PROPERTIES OF PLATE MATERIAL AND FINISHED PIPE

Ultimate strength, psi	70000
Yield strength, psi	41250
Elongation in 2 in., per cent	32
Elongation in 8 in., per cent	18
Chemical properties of plate material:	
Carbon, per cent (max)	0.30
Maximum manganese, per cent	0.85 to 1.15
Phosphorus, per cent (max)	0.045
Sulphur, per cent (max)	0.050
Minimum physical properties of finished pipe:	
Ultimate strength, psi	72000
Yield point—longitudinal, psi	44000
Yield point—transverse, psi	52000
Elongation in 2 in., per cent	22

It will be observed that the physical properties of the finished pipe show an improvement over the plate from which it is made. This is the result of a certain amount of cold-working of the pipe in the final sizing after forming and welding. The sizing procedure of most pipe mills consists of expanding the pipe a certain amount inside a rigid steel form by hydraulic pressure, thus bringing about a measure of cold-working.

It should be mentioned that every length of large-diameter pipe is hydrostatically tested at the mill before shipment, and most pipe mills apply a test pressure which will stress the plate material in the pipe to about 90 per cent of its yield point.

In order that the purchaser of pipe may be assured that all pipe produced by a mill meets the specifications agreed to in the purchase contract, a pipe-inspection service is utilized to check all details deemed pertinent to the finished pipe. The representative of the inspection service checks the completed pipe for such characteristics as roundness, variation in inside and outside diameter, accuracy of end beveling, straightness of pipe, defects in plate material which show up during hydrostatic tests, and many other details.

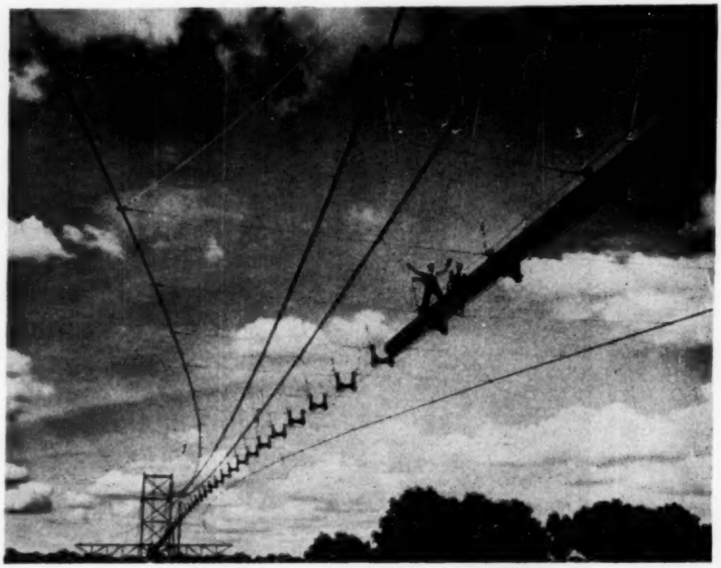
The inspector on the job also selects pipe from which coupons are cut for determination of the physical properties of the finished pipe. Some of these coupons are in the plate material alone while others include the longitudinal welded seam. The final report of the inspection service provides specific information on the physicals and chemicals of all heats from which the plate used in the pipe came, physicals and chemicals of all coupons cut from the finished pipe, test-pressure conditions, and a rather large amount of detailed information on the experience of the mill during production of the pipe.

Most present-day cross-country pipe lines are designed to operate at a maximum pressure which will stress the material to about 70 per cent of the yield point of the finished pipe. Inasmuch as gas-transmission lines are not subjected to pressure surges as in the case of liquid lines, these high unit stresses are well within safe operating limits. Experience over several years has proved that gas pipe lines, which are welded in accordance with strict specifications and are properly coated, wrapped, and protected against corrosion provide dependable operation.

COMPRESSOR STATIONS

In the design of long-distance gas-transmission pipe lines, provision must be made for compressing the gas at fairly frequent intervals. The spacing of compressor plants will vary considerably with the various pipe-line companies. It has been found that the investment versus total long-life operating-and-maintenance-cost relationship is significant. The desired capacity in the pipe line, diameter of the pipe, and total length of line are also factors which must be considered in arriving at compressor-station spacing.

Many early long-distance natural-gas pipe lines were built with compressor plants almost 100 miles apart and with ratios of compression as high as 2.5. In recent years, however, the distance between pumping plants has been reduced along with the ratio of compression, and some pipe lines operating at around 750 to 800 lb have ratios of compression as low as 1.4, and station spacing of 75 miles or less. Inasmuch as many factors must be considered in designing a gas-transmission system, and, since initially the ultimate capacity of the system is not usually known, it is believed that a definite spacing rule to fit every case cannot be predicted beforehand. There is indication, however, that larger-capacity-pipe lines favor closer station spacing and lower ratios of compression.



SEEMINGLY DEFYING THE LAWS OF GRAVITY, WORKMEN SLOWLY GUIDE HUGE SECTION OF 24-IN. PIPE ACROSS AERIAL SUSPENSION BRIDGE OVER BRAZOS RIVER IN TEXAS

(TGT's lines cross 67 rivers from the Rio Grande to the Shenandoah—24 of these water barriers means special engineering skill.)

The majority of the compressor plants on long gas-transmission pipe lines are equipped with direct-driven reciprocating gas-engine units. These units vary considerably in size with the largest being approximately 2400 hp. They may be either two-stroke-cycle units or four-stroke-cycle units, but in recent years the trend has been toward two-stroke-cycle units in the natural-gas-transmission business. There are proponents of each type, but the author will avoid contributing to a possible controversy on this subject by withholding his personal opinion on the matter.

Electric-power-driven centrifugal gas-compressor units, operating at a discharge pressure in excess of 700 lb, have been in use for more than 2 years on long-distance natural-gas pipe-line systems. The centrifugal compressor has proved entirely successful thermodynamically and mechanically in this application.

Several manufacturers of industrial combustion-gas turbines are now working on designs which it is hoped will be suitable for driving centrifugal compressors in gas pipe lines. These gas turbines, if successful, will use natural gas for fuel and drive centrifugal compressors at speeds up to a maximum of perhaps 7000 rpm.

It is not possible at this time to predict size ranges of combustion-gas turbines for gas-transmission systems. Such factors as capacity of the pipe-line system, ratio of compression, and desired flexibility of operation enter into the problem of selecting a unit. On systems having two or more large-diameter paralleling pipe lines, it is the author's opinion that a unit of 5000 or 6000 hp is not too large. In its present state of development, the heavy-duty, industrial-type, combustion gas turbine is not so attractive in sizes around 2000 and 3000 hp. It appears desirable that the combustion gas turbine for gas-transmission-system service have an over-all thermal efficiency equal to or in excess of that of the present-day two-cycle gas engine widely used for that application.

Developments to date indicate that it is feasible to produce a combustion gas turbine with efficiencies equal to that of the two-stroke-cycle gas engine.

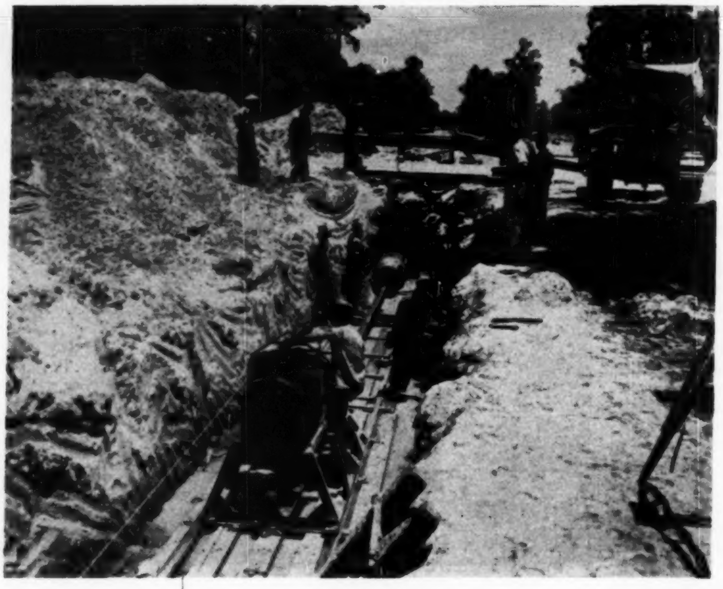
CORROSION PROTECTION

In connection with protecting pipe lines against corrosion and stray currents by the cathodic method, it may be of interest to note that the more completely a pipe line is coated and wrapped the more easily and economically can it be protected by this method. The cathodic principle of protecting pipe lines involves the use of direct current, and power-rectifying units are generally installed to obtain the required direct current for this purpose.

Most gas-transmission pipe lines are buried with at least 24 in. of soil covering on the pipe and, in many cases, they are installed at a much greater depth. The primary purpose in having this amount of covering on the pipe is to permit cultivation of the land through which the pipe line passes and to prevent damage to the pipe by cultivation machinery.

RAILROAD AND RIVER CROSSINGS

All railroad crossings and most paved-highway crossings are carried out by installing the carrier pipe inside a casing pipe. The wall thickness of the crossing carrier pipe is usually greater than that of the cross-country pipe line of which it is a part. The casing pipe is generally 4 to 6 in. greater in diameter than the carrier pipe, and, since it withstands no internal pressure, wall thickness is not significant. Cased railroad and highway crossings are constructed so that the carrier pipe is insulated electrically from the casing, and this is accomplished by coating and wrapping the carrier pipe properly and supporting it on insulating blocks which in turn rest on the casing. Cased cross-



PIPE LINE CROSSES UNDER 274 HIGHWAYS

(Not to disrupt traffic, huge augers bore holes beneath highways through which pipe may be pushed.)

ings are sealed at each end and then vented by means of pipe risers extending above ground level.

If possible, river crossings are made under water, but owing to the nature of some river beds, overhead crossings are more satisfactory. Underwater crossings are carried out by installing heavy-wall pipe (usually $^1/_2$-in. wall thickness for 24-in., 26-in., and 30-in. diam pipe) in a ditch cut into the bed of the river. On most rivers the operation is accomplished by welding together on land enough pipe to extend entirely across the river, adding the necessary weighting material and then pulling the pipe into position in the ditch. Weighting material may be cast iron or concrete river weights bolted to the pipe at definite spacings, or it may be a uniform coating of reinforced concrete applied to the entire river crossing. Cover on the pipe in a river crossing may vary from a foot or two in rocky beds up to several feet where the river bottom is silt or sand subject to considerable shifting. Overhead crossings may be upon highway or railway bridges, and in many instances they consist of a suspension bridge built specifically for accommodating one or more pipe lines.

These suspension bridges are expensive to build but do offer the advantage of permitting inspection of the pipe line at all times. Maintenance expenditures on suspension bridges are mostly for painting.

EFFECT OF TEMPERATURE ON PIPE-LINE CAPACITY

The flowing temperature of gas has a definite bearing on the capacity of a pipe line. It has been found that within the range of temperatures encountered by most long-distance pipe lines in this country a change of 10 deg F results in a variation of about 1 per cent in the pipe-line capacity. Many pipe lines have a variation of more than 25 per cent between summer and winter, and, fortunately, the increased capacity occurs during the winter when the demand for gas from a transmission system is usually heaviest.

In order to increase the capacity of a pipe-line system, most gas-transmission companies install cooling equipment at compressor plants to remove a major part of the heat of compression. It has been found that gas from a compressor plant, where cooling is not carried out and where the ratio of compression is in the neighborhood of 2.5, must travel 20 to 30 miles before it reaches ground temperature.

In the Southwest and Midwest the economics of gas transmission seem generally to favor gas cooling at compressor plants, especially where the ratios of compression are relatively high. In the case of gas-transmission systems extending into cold sections of the country the advantages of cooling gas become less important because of the prevailing low ground temperatures most of the year.

The question, "How fast does gas travel in a pipe line?" is one frequently asked by those not associated with the gas-transmission industry. As an example, in a pipe line operating at 750 lb with compressor-plant spacing of around 75 to 80 miles and ratios of compression of the magnitude of 1.5, the average gas velocity is about 17 mph. As a rule, the velocity of gas in a major gas-pipe-line transmission system in this country ranges between 14 and 25 mph.

In carrying out natural-gas-pipe-line capacity calculations the "panhandle formula" for a number of years has been the most generally accepted method. This simplified formula is an improvement over the "Weymouth formula," and was developed a number of years ago by personnel connected with Panhandle Eastern Pipe Line Company. It lends itself to adaptation to a slide rule, and several such devices are on the market. The pipe-line slide rule is a real timesaver and is sufficiently accurate for all design calculations.

MECHANICAL TIME STUDIES

By ALEX. N. ENGBLOM

PRESIDENT, A.-B. DYESTUFF CHEMICAL CORPORATION, GOTHENBURG, SWEDEN. FELLOW ASME

INTRODUCTION

As a young man, I was employed by a textile mill in this country for eight years, from 1909 to 1917. Those years gave me the wonderful opportunity to meet some of the outstanding pioneers in the scientific-management field.

Being a member of this Society and of the Taylor Society, I was able to follow the vivid discussions of the revolutionary ideas and new philosophies which were highly debated and opposed at that time. Today, we have accepted the ideas of scientific management; we have seen them become co-ordinated, integrated, and further developed. Today, they constitute an essential part of our thinking. It is difficult to look back to those days and to understand how the enthusiastic and burning discussions penetrated and exploded our earlier viewpoints on industrial problems.

The textile mill I worked for called in Emerson as a consulting engineer, and I got a practical education in the application of the principles and systems of scientific management.

The inspirations I received from personal contact with men such as Taylor, Emerson, Gantt, and others have had a fundamental influence on my work throughout the years that followed.

During the 30 years of work in a textile mill in Sweden, I have had excellent opportunities to practice the ideas and to apply the time-study techniques taught me here in the United States.

When I speak of time studies, it is not in the narrow sense of the words; I think in terms of the comprehensive definition given, for example, by Maynard, Stegemerten, and Lowry, which is as follows:

"To subject each operation of a given piece of work to close analysis, in order that every unnecessary operation may be eliminated and in order to determine the quickest and best method of performing each necessary operation; also to standardize equipment, methods, and working conditions. Then, and not until then, to determine by scientific measurement the number of standard hours in which an average man can do the job."

THE MECHANICAL REGISTERING DEVICE AS A MANAGEMENT TOOL

My presentation of mechanical time studies will deal with mechanical devices that record the utilization of the various productive machines on a time chart. The machines are connected directly with the central registering instrument.

I wish to demonstrate how these mechanical devices can become a valuable auxiliary tool for the analysis of productivity as well as for other management control functions.

The principal purpose of the time study is to improve work methods. To obtain good results, we must have well-trained and qualified time-study personnel and good co-operation between the various departments of the company. Wholehearted top-management support is another important necessity.

Contributed by the Textile Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers.

A time study carried out in the traditional way is, in general, done once and is also limited in time because of economical reasons. On the other hand, we should quite often like to extend the study and thus be able to analyze the causes of delay more thoroughly. This, perhaps, would enable us to eliminate some of the hidden weak points and increase the efficiency of the machines. An effective utilization of machines is especially important with the expensive machinery used in the textile industry.

If we wish to achieve the advantages offered by long-period studies, we have to depend on other and more economical means than the manually handled stop watch.

Stop-watch time studies also have other shortcomings as a result of the limitations of human senses and judgments. The reading of a stop watch is not an accurate fixation of the time. It is also difficult for a time-study man to follow and record the operations on more than a few machines.

In the past few years a new work-measurement technique, "methods-time measurement," has been developed. This procedure makes it possible to set accurate standards on manual work without using a stop watch. It does not involve the same amount of inaccuracies and judgment as time studies, but the need for an accurate device for the timing of the machine time has not disappeared. We have a very well-balanced combination when we use the mechanical registering device to follow the machine time and methods-time measurement for the analysis of the manual work.

When we have analyzed, simplified, and standardized the work methods, we can base the wage-incentive system on the resulting standard times. This will make the workers interested in keeping the delay time down to a minimum.

Unfortunately, however, the workers are able to influence only some of the down time. For instance, delivery of material or down time caused by repairs is outside the control of the workers. Management has the responsibility for the attainment of the best possible result of production. To obtain it, management has to help the workers with the elimination of delays and down time.

We have a means for this down-time control and for the prolonged time analysis in mechanical registering instruments. These have been constructed in Sweden, where they are widely used. When we in this way extend the time studies to a continuous analysis, we actually have dissolved the border line between time studies and the control of the working of the machines. The time study has become a part of the production-control function.

When we consider mechanical time study, I shall thus have to discuss the time study and the down-time control as a unit, without drawing any fixed border line between the one and the other.

Mechanical or electrical time-study equipment that is operated manually by the analyst certainly will be able to make a chart of machine operating time. But this is not the kind of equipment I wish to discuss. It has too many of the disadvantages of the manual time study.

A number of fairly simple instruments that are attached directly on the machines are a step in the direction of the fully developed centralized instruments we shall discuss in detail.

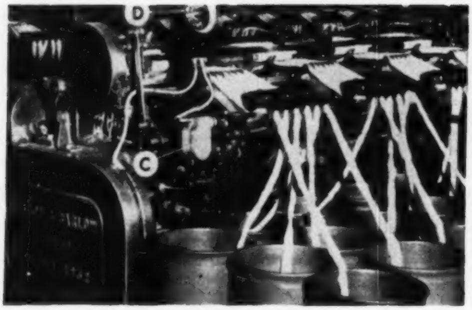


FIG. 1 APPLICATION OF CENTRALOGRAPH TO DRAWING FRAMES
(C is the machine contact and D is the dial for selecting work-stoppage cause.)

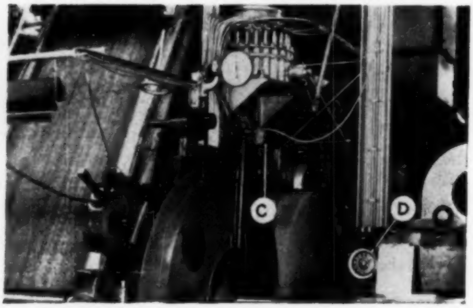


FIG. 2 APPLICATION OF CENTRALOGRAPH TO PRINTING MACHINES
(C is the machine contact and D is the dial for selecting work-stoppage cause.)

These simple devices can be used for prolonged time studies and down-time analysis. They are connected with a rotating or moving part on the machine. The time the machine is working is recorded on a circular chart that is rotated by a clock. The chart in the instrument has to be changed every day or in some cases only once a week. These recorders can be used both on movable equipment, such as trucks, bulldozers, cranes, and machine shovels, and on stationary machines, such as textile machinery, stone crushers, conveyers, rolling mills, and other types of large and expensive equipment, where it is important to avoid unnecessary delays. In general, it is preferable to use a central registering instrument for stationary machinery in a plant or a department.

DESCRIPTION OF CENTRAL REGISTERING DEVICES

Four of the best known and most widely used makes of Swedish central registering devices are as follows: L. M. Ericsson's "Centralograph," AB Ljussignaler's "Central-Instrument," AB Telesignal's "Tempograph," AB Elsignaler's "Elektrograph."

The working of the machines is recorded on a chart paper that is fed through the instrument at a constant speed. This is a common feature for all four makes. On this chart paper, one column corresponds to each of the supervised machines. The size of the central instrument and the width of the chart paper corresponds to the number of machines supervised.

Let us take a close look at the functioning of the Centralograph.

The Machine Contact. An electric contact is mounted on each of the machines the Centralograph has to check, Figs. 1 and 2. These machine contacts are connected individually to the recorder through a system of cabling. Contacts on machines in productive operation automatically transmit electrical impulses to the central instrument. The impulses activate small tracing pins or hammers, which record the diagrams on the chart paper. The machines supervised are recorded side by side on the continuously moving paper. The chart is known as the "centralogram."

The machine contact may be operated mechanically by a particular movement on the machine such as a rotating or reciprocating movement, or electrically in conjunction with the motor on the machine. In some cases we use machine contacts operating on other principles.

The choice of the machine contact should be made so that we obtain adequate and reliable recording in the most convenient way.

The Dial. A dial, Fig. 3, that looks very much like a normal telephone dial, is mounted on or near the machine. As soon as the machine stops for any reason, the operator dials the code number corresponding to the reason for each particular machine stop. This code number is transmitted to the Centralograph, Fig. 4, by means of electrical impulses, and is printed on the diagram, Fig. 5, opposite the recorded stoppage. In this way we have a clear indication of why the machine is idle.

The Centralograph. The Centralograph prints the recordings, lines, and figures on the centralogram through an ink ribbon in the same way as on a typewriter. The chart paper is driven continuously past the printing mechanism and out of the instrument by means of a motor running at constant speed. The paper travels a given distance per hour. The drive gear may be adjusted for different rates of paper travel.

FIG. 3 DIAL FOR DIALING CODE NUMBER CORRESPONDING TO WORK-STOPPAGE CAUSE

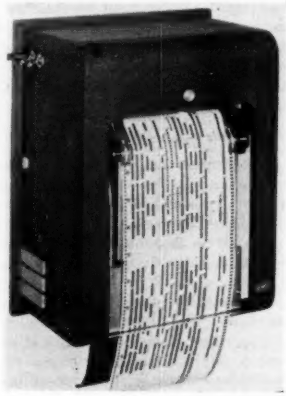


FIG. 4 CENTRALOGRAPH TO WHICH CODE NUMBER IS TRANSMITTED ELECTRICALLY AND RECORDED

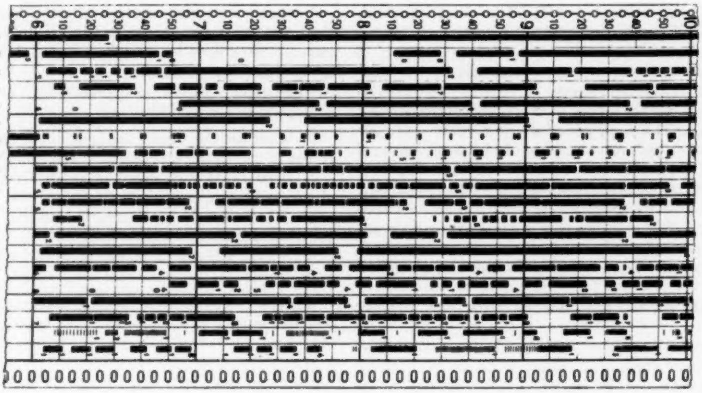


FIG. 5 CENTRALOGRAM, THE CHART PAPER ON WHICH CODE NUMBER IS PRINTED, GIVING CLEAR INDICATION OF WHY MACHINE IS IDLE (NUMBERS), LENGTH OF STOPS (BLANKS IN LINES), AND OPERATING TIMES (BLACK LINES)

The Centralogram. I have already mentioned that the working of each supervised machine is recorded in a separate column on the centralogram. The machine-time registration consists of a series of short horizontal lines, one for each impulse from the machine.

These lines form bands with open or closed appearance depending on the frequency of the impulses. We usually prefer close registration bands, because this recording is more definite. The open registration bands may be used to give an approximate idea of the production rate; the density of the line registrations will vary with the speed of the machine.

The reasons for the stoppages are recorded in the centralogram by figures 0 to 9 immediately to the right of the corresponding machine-time registration.

We are able to follow the machine performance closely on the centralogram. The records show when a stoppage has taken place, how long it lasted, and why it has occurred.

The Central-Instrument. The Central-Instrument operates on the same principle as the Centralograph. The tracing system is somewhat different. The Central-Instrument is equipped with 24 double-writing drawing pens. Every drawing pen can register the effective working time of two machines on each side of a middle line, or a total of four machines.

If we want the reason for the stoppage recorded on the paper, then only two machines can be connected with each drawing pen. When the machine has to be stopped, the worker adjusts a manual-report contact to the position corresponding to the reason for the stoppage. This will give a corresponding registration on the diagram paper.

The varying registration makes it possible to read on the diagram paper how long and for what reason the machines have been ineffective. This can be measured per day, per week, or for any other period during which the studies have been carried on.

The other products differ in some ways from the two described, but the main principles are the same.

DAILY PROCEDURE FOR THE CENTRALOGRAM

The centralogram for the previous day should be cut off each morning. If we work shifts in the factory, it is more convenient to divide the centralogram so that each shift appears on a separate length of chart.

The number of the Centralograph, the shift day, week number, year, and date are written on the top of the centralogram. The starting and finishing times of work, as well as rest and meal intervals, are indicated with red lines across the centralogram.

The centralogram is also supplemented with notes about certain stoppages not reported by code. This information is acquired from the department executive. It is his responsibility to see that the centralogram is complete in this respect. The dial registration may be omitted deliberately for certain stoppages, such as the following:

1 Rest and meal intervals, for which the time and duration are determined in advance. They require no particular notes on the centralogram.

2 Machine stoppage, due to major repairs of the machine, lack of orders on the machine, or because the operator is absent from work. A note should be made on the centralogram in this case.

3 Certain short, recurrent stoppages can be specified in advance not to be dialed. We do not need to note them, as they are recognizable from the appearance of the diagram.

When the operator neglects to dial some stoppages, the centralogram must be completed with the appropriate figure.

A change of product or a change of lot indicated by a dial recording should be supplemented with the code of the new product.

Normally the completed centralogram is given to the head of the department for examination.

Centralograms are filed daily or weekly after the necessary information and statistics have been computed.

USE OF THE RECORDED INFORMATION

The recorded information may be used for many purposes:

1 Data and statistics for time studies.
2 Data for wage incentives and wage compensations.
3 Quality control.
4 Increasing and supervising efficiency.
5 Data for planning and costing.

Time Studies. All methods engineering has the purpose of obtaining the most economical use of the production factors.

The implication of this is that we must reduce the delay times to a minimum. All production-curbing factors have to be controlled.

Time studies are important tools for systematic analysis and reduction of these restraining factors.

The Centralograph makes it possible to obtain comprehensive data and statistics over a long period of time—data that will give a representative and accurate idea of the work pattern. The analysis will show where it is possible to make improvements in the organization of the work and in working methods.

The statistics can also show where further investigations will be necessary. When stop-watch studies or methods analysis have been made of the manual operations, we can check to see if the values are representative for the average conditions.

After improvements, the centralogram will show the size of the achieved results.

Stoppage Statistics. "Stoppage statistics" give a continuous and clear summary of stoppages, arranged weekly by stoppage reason. The numerical value of the stoppages should be expressed in such a way that the different reasons can be compared, as well as the pattern changes from week to week.

The stoppage statistics can refer to groups of machines or to a single machine.

The machines are, in the first case, divided into groups on the basis of size, condition, and so on. Each machine group is treated separately. Statistics should primarily be prepared for unoccupied time, lost time, and set-up time. When it is possible to obtain handworking time comparable from week to week, this should be included.

It may be of interest sometimes to run weekly statistics per individual machine. Normal stoppage statistics per machine group should, however, always be run concurrently.

Products Statistics. Certain time elements vary for different products. We can obtain useful information by arranging these time elements statistically by product. This is known as "products statistics" and may refer to production time per unit produced, frequency, and duration of certain stoppages typical for the product, and so forth. The production time depends on the speed of the machine and on the frequency and duration of stoppages. The frequency of such stoppages may be influenced by the quality of the raw material or the speed and setting of the machine, whereas the duration of the stoppages may be affected by the method of production.

Products statistics make it possible to compare values obtained for different runs of the same item.

Products statistics may be justified only when the same or similar products are subject to repeated production. Furthermore, there must exist adequate need for the data obtained, such as possibilities of reducing the production time. We may obtain such reduction by altering the method of production, changing the speed or setting of the machine, selecting different raw materials or making minor changes in the preceding processes.

The statistical values should be worked out per machine. The covered period should be the batch time for production in relatively small lots, or a week for continuous production of the same articles.

It is advisable to work out standard values for products subjected to the statistics—values that are considered representative for a certain period. Abnormal deviations become immediately apparent when these standard values are entered on the specification sheet and the graph sheet. No reference needs to be made to earlier statistics.

Quality Control in the Textile Industry. In most of the operations in the textile industry, production depends on variations in quality. An example is the varying frequency of ends down.

For certain machines, such as looms, it is now possible to obtain an automatic recording of ends down on the centralogram. This is done by the use of a special device that is fitted to the warp stop motion.

This device will enable management to obtain answers to such questions as the following:

1 What are the figures for ends down on the different machines of the same type, spinning the same quality and count?
2 How many ends down occur in a machine just after a change of material or count?
3 What effect does a change in humidity have on the number of ends down?
4 What effect does a change of speed have on the number of ends down?

The answers will make it possible to get optimum production, and the quality of the products will be improved through the decreased number of ends down. This control of quality can be carried on continually.

Increasing and Supervising Efficiency. The production is sometimes of such a character that immediate corrective action from management very seldom will be necessary. In this case we do not need to have somebody continually watching and controlling the Centralograph. In most cases, we prefer to have a manned Centralograph station. This will enable us to discover almost instantly if something goes wrong, and quick action can be taken.

The person who is doing the statistical analysis of the centralogram can just as well be placed in the Centralograph control room as anywhere else. Thus we have the advantages of a manned station.

The next possible development would be to give the Centralograph control man the authority to initiate corrective action to remedy certain problems created in the mill.

Managers and supervisors have been opposed to this idea because they thought it would destroy the normal report and order channels. In this way they would lose contact with and control over the operations. Experience has shown that this is not true.

We can consider a plant with diversified manufacture and where the processes are quite automatic. Here the Centralograph station is a point from where quick information can be sent to the department manager, the production-control engineer, the works engineer, and others concerned. The foreman for the shop also can receive accurate and immediate notice if anything happens.

We can also free the supervisors from many of the smaller and more routine details that create delays.

Causes of this character are (for instance):

1 Lack of material at a work station.
2 Delayed material delivery.
3 Smaller repair jobs on the machines.

The Centralograph station can notify the storeroom if materials are needed. If the plant has a special interval transport section, it can be ordered to the critical points with materials. The delivery time can also be checked by the centralogram.

The instrument control man can call on the repair man, if a breakdown occurs. If all the repair men are occupied with service repair at the same time, the control man will have to call on the production-control chief, who can decide which repair jobs are the most urgent.

This service will save a lot of the supervisory personnel's valuable time.

To increase still more the effective working time of the machines, we can add lamp and searcher boards to our system.

The lamp board contains lamps corresponding to the machines equipped with manual report contacts. As soon as a report contact or dial has transmitted the reason for the machine stop to the control instrument, the corresponding lamp is lighted on the board. This clearly shows that there is something wrong at the moment. The lamp board can be placed near the Centralograph or in the office of the executive concerned. He therefore rapidly gets to know when any machine is stopped and can contribute to a quick removal of the cause.

Searcher boards contain lamps corresponding to the departments that are controlled by the Centralograph. They can be mounted at suitable places in the works premises.

The searcher boards are used for searching of the overseer. When the worker adjusts his dial to a certain position, for instance 3, the corresponding department lamp is lighted up on all boards. It signals to the overseer that he is needed in the particular department.

The combination of central instrument, lamp board, searcher boards, and report dials has in practice proved to be very effective.

The system can be completed with either efficiency recording clocks or counters. The time for the effective as well as for the ineffective working time can be read directly off these instruments.

Other Applications. During late years the application of these recording instruments has been expanded greatly in fields where the control has been found valuable.

They can be used to control the condition and maintenance of the machinery. This can be a guide for the investment in new machines, so that renewal is done neither too early nor too late.

The Centralograph is a very reliable watchdog for various processes, where the pressure and the temperature should be held within certain limits. Also, fire safety doors can be controlled by contacts mounted on the doors.

SUMMARY

Central registering instruments, together with various types of auxiliary equipment, will make it possible to get a complete picture of how the machines are running, how they are maintained, and how good the methods are. The system can be used for long-time analysis, as well as for the daily supervision of the machines. With the assistance of a central instrument, the time-and-methods-study man can work up his material for many machines simultaneously. It enables him to move freely among the machines and make his observations of the manual operations.

The results from various industries talk a very convincing language. They show that the central registering instrument is a reliable aid for obtaining increased productivity and a good uniform quality.

One particular Swedish mill installed the Centralograph system and after a few years' application, the management had been able to cut down the delay times from 7.4 per cent of the total time to 1.1 per cent. Centralogram reports as to the condition and efficiency of the machines have further enabled management to determine what machine make is to be preferred for the different operations. Such information is valuable as a sound basis for new investments.

Labor has very often shown caution and opposition when the installation of an automatic registering system has been discussed. This opposition is rooted in a general suspicion of management controls. The word "control" doesn't sound good when it can be associated with any form of "man control."

The workers feel that the supervision already is sufficiently close. They claim that the employers should have more confidence in the employees and show it in practice.

This opposition is simply based on a misunderstanding of the whole purpose of the automatic registering instrument. To change this attitude, we have to give a very thorough and careful explanation of the true objectives and show how everybody can benefit from the installation, management as well as workers and consumers.

The worker, who knows that difficult obstacles sometimes hamper his performance, can substantiate it with the aid of the centralogram. He no longer needs to argue with the time-study man because it did not show up in the time study, when everything ran smoothly. It will also help him to perform his operation without annoying delays.

The mechanical registering device is not a substitute for normal time studies, but is a valuable complementary tool. At the same time it gives us an important means for the continuous control of the utilization and performance of machines.

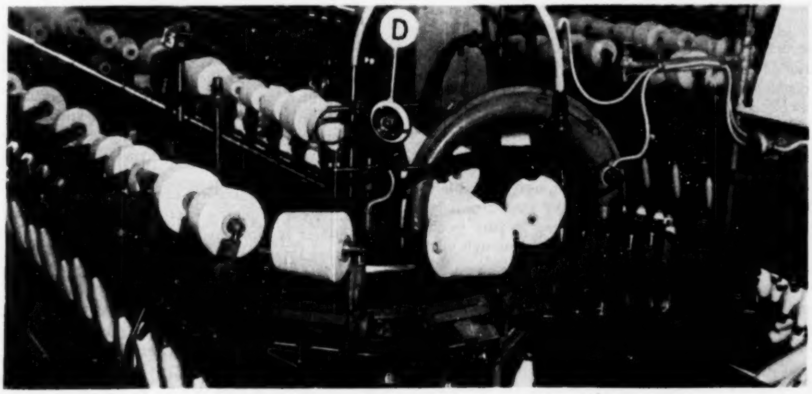


FIG. 6 APPLICATION OF CENTRALOGRAPH TO WINDERS
(D is the dial for selecting work-stoppage cause).

The Steam-Generating Station as a Source and Sink for the Heat Pump

By J. A. EIBLING[1] and B. A. LANDRY[2]

BATTELLE MEMORIAL INSTITUTE, COLUMBUS, OHIO

INTRODUCTION

THE economic reasons that favor centralization of our various business activities into large units are not without their counterparts which favor decentralization. Thus department stores in many instances appear to have reached their maximum-size usefulness for saving space and labor and no longer can attract a continuously increasing number of customers because of automobile parking and other transportation difficulties. Such stores have found it advantageous, as a means of increasing their total volume of business, to open branch establishments of smaller sizes where ample parking space is available. The same tendency can be noted in various other types of business.

This decentralization tendency has not yet appeared in power generation from steam, although it can be noted that a relative maximum size seems to have been reached. New large stations, in metropolitan and other areas, are now being built at some distance away from previously existing stations, for a number of reasons, but not for the purpose of increasing the total volume of business as a result of the change in location.

The system described in this paper of utilizing a steam-electric generating station as a source and sink of heat for heat pumps will require for its application extended decentralization of stations and a considerable decrease in the installed capacity of these stations in comparison with present large stations. Hence operating costs are bound to be higher. But, if a new market for electric energy, which would not develop otherwise, can be established by this process, decentralization would appear to be justified, as it has been for branch department stores.

Residential summer cooling can be expected eventually to become an integral part of our standard of living. Any enterprise whose objective coincides with increased standards is bound to prosper in the long run. Such a future may be in store for the type of development proposed.

It may be added that the continuing international situation can in no way be considered a deterrent to decentralization.

GENERAL DESCRIPTION

The climate of the United States is such that summer cooling of residences would be most desirable. Although available in principle, cooling has not reached extensive application because of the high initial cost involved, owing in part to the fact that cooling has not been associated closely enough with heating.

Proponents of the heat pump pointed out long ago, however, that compression refrigeration, which is the most efficient way of producing cooling, may also be used for heating by reversing the functions of the evaporator and condenser. Thus one machine can provide both heating and cooling. Moreover, the thermodynamic advantage of the heat pump makes it feasible to do this with electricity, which is the most convenient form of energy for residential use.

Realizing the great potentialities which the heat pump offers, the electric utilities and a number of manufacturers have, in the last two years alone, invested an estimated $1,000,000 in at least twenty-five separate research projects on the heat pump.[3] As a result, great progress has been made, but there is still much to be done to develop this device to the point where it will have widespread application.

It is generally agreed by all who have concerned themselves with the heat pump that the principal problem is providing a suitable heat source.[4] This is especially true in northern localities where the maximum heating load is about twice the maximum cooling load. The ideal solution is one whereby the (1) size of the compression-refrigeration unit required for cooling the house would also be adequate for heating the house, and (2) the total costs for heating, with electric energy available at average prices, would compare with those of automatic heat with competitive fuels.

In searching for a solution to this problem in connection with the heating and cooling of groups of residences or housing projects, an interesting possibility has been investigated. This is that of using the waste heat in the condensing cooling water from steam-power generation as a source of heat for heat pumps in dwellings. For cooling, a centrally located spray pond would serve as a heat sink. As a necessary feature, it is considered that each dwelling would be all electric in that not only the heating and cooling functions, but also cooking, service-water heating, household refrigeration, in addition to lighting and operation of other appliances, would be performed by electricity.

This paper is concerned mainly with the factors involved in this application. The background material has been supplied from extensive studies made at Battelle for Bituminous Coal Research, Inc., on the subject of district heating, or rather residential group heating. Purely for comparative purposes, the paper compares costs of the proposed system with those associated with heat pumps utilizing the earth as a source of heat.

The proposed application involves installation of an underground system of piping (hereafter called the loop) through which water is circulated between the power plant and the heat pumps located in the dwellings. During the heating season, the loop water passes through the steam condensers of the turbogenerators and thereby serves the dual functions of condensing cooling water and of heat source for the heat pumps.

Fig. 1 shows the system schematically with assumed temperatures for heating-season operation. For simplicity, only

[1] Research Engineer, Fuels Research.

[2] Supervisor, Fuels Research. Mem. ASME.

Contributed by the Power Division and presented at the Spring Meeting, Atlanta, Ga., April 2–5, 1951, of The American Society of Mechanical Engineers.

[3] "Heat Pump Progress in the United States," by Philip Sporn, E. R. Ambrose, and Theodore Baumeister, Fourth World Power Conference, London, England, 1950, Paper No. 4, sect. K.

[4] "The Heat Pump, Heat Sources and Sinks," by R. C. Jordan, et al., *Heating, Piping, & Air Conditioning*, November, 1950, pp. 87–91.

one turbogenerator and only one heat pump are shown. The heat pump is of conventional design of the water-to-air type and may be equipped for either manual or automatic seasonal change-over. A thermostatic-type expansion valve is implied, for operation on the heating cycle, so that the highest possible evaporation temperature can be maintained automatically with slight variations in the temperature of the loop water.

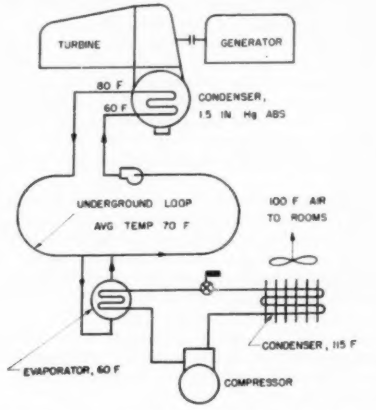


FIG. 1 SCHEMATIC DIAGRAM FOR UTILIZATION OF CONDENSING COOLING WATER AS A SOURCE OF HEAT

The heat pump, shown in Fig. 1, is considered to be at the center of the loop. Those on either side of the center would operate at higher or lower evaporator temperatures, depending on whether they are upstream or downstream in relation to the direction of flow of water. Since the evaporator temperature affects the efficiency, there would be a difference in the power requirements of the units distributed along the loop. This difference is not objectionable where the heating service is included in the rent or where a flat-rate charge is used. But where each customer is billed according to the power consumed, some compensating arrangement would be required. One method suggested is to reverse the direction of flow periodically. This might be done as infrequently as once each year, or several times a year in accordance with a schedule based on degree-days and cooling hours. Another method might be to maintain flow in one direction and include a water-temperature factor in the power rates.

The temperature of the loop water can be controlled easily by regulating the rate of flow and by mixing the loop water with cold water from a cooling pond.

During the summer months, the loop water becomes a heat sink for the heat pumps and is pumped directly to a spray pond or cooling tower, by-passing the steam condensers. The condenser cooling water, now flowing in an independent cycle, is also cooled in the spray pond, if no other means, such as a nearby stream or lake, is available. On the basis of a 20 F temperature rise in the loop, typical operating temperatures during the summer would be as follows:

	Temperature, deg F
Water entering spray pond	105
Water leaving spray pond	85
Average loop water	95
Evaporator	45
Condenser	105

In practice, of course, the so-called loop would be a network of piping laid out according to accepted standards for minimizing investment and pumping costs. Whenever possible, the piping passes through the basements of the buildings to reduce excavation costs. Since low-temperature water is circulated, very little thermal insulation is required. In fact, under certain circumstances, bare piping could be used. Bare piping would be feasible where the loop temperature is the same as that of the surrounding earth, or where at a higher temperature, there is considerably more waste heat in the condensing cooling water than needed by the the heat pumps. With water at an average temperature of 70 F, assumed purely as an example, it is conceivable that possibly a corrosion-protective coating of asphaltum would suffice in very dry soils. In wet soils, a thin layer of insulating concrete could be poured around the pipe or the pipe could be encased in sewer tile. In any case, the piping would be relatively inexpensive, costing an estimated one third to one half of the cost of underground steam or hot-water systems.

ADVANTAGES AND LIMITATIONS

Of all the known sources of heat for the heat pump, the heat in condensing cooling water appears to come nearest to an ideal one. Except for cost of pumping and piping this heat, it is just as "free" as the natural heat sources. Normally, it is wasted to nearby rivers or dissipated to the atmosphere in cooling towers; it is always produced when electricity for operating heat pumps and other electrical appliances is generated from steam.

Unlike natural heat sources, the loop water is not affected by climatic conditions or local legal restrictions and its temperature can be so controlled that a high coefficient of performance can be obtained by its use, thus minimizing both the size of the unit and its power consumption.

Fig. 2 shows the effect of the temperature of the evaporator which depends on the temperature of the heat source, on the

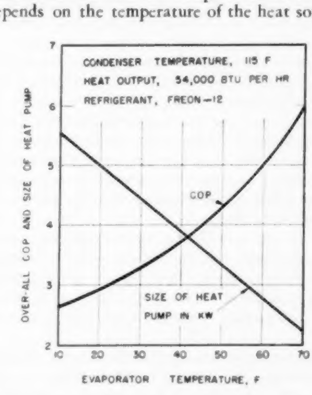


FIG. 2 EFFECT OF EVAPORATOR TEMPERATURE ON COP AND SIZE OF HEAT PUMP

coefficient of performance (cop), and on the size of a heat pump, required to meet a given heating load. In preparing Fig. 2, over-all motor-compressor efficiencies of 56 to 60 per cent, depending on the ratio of compression, were used. The cop curve includes power input to the compressor motor and to the fan motor, but does not include power for circulating the loop water. Motor and compressor losses have been assumed to be recoverable as useful heat. The size of heat pump is expressed in terms of kilowatt input to the compressor motor

only. The fan motor consumes an estimated additional 0.4 kw, which is taken into consideration in the cop curve. It is believed that Fig. 2 is representative of the performance that can be expected of present-day heat pumps operating under the conditions necessary to supply 100 to 105-F air at the registers.

Another advantage of this system is that the undesirable feature associated with air and earth heat sources which require that the heat pump be sized for the maximum heat demand, at the lowest evaporator temperature, is eliminated. Moreover, with condenser cooling water, a heat pump properly sized for cooling is adequate, or nearly so, for heating. This is of great significance in northern localities where the maximum heating demand is about twice the maximum cooling load. Not only does this reduce the size of the unit and improve the cop, but it also improves the annual load factor of the power system.

Certain other desirable features in the design and operation of the heat pump are also indicated. Heat transfer between water and the refrigerant lends itself to small and efficient heat exchangers. Scaling and corrosion of the heat-transfer surfaces and piping are held to a minimum with only treatment of make-up water required. The pressure drop of the refrigerant in the evaporator is small in relation to that in ground coils, and much less refrigerant is required. There is an automatic reduction in compressor capacity when the unit switches from heating to cooling, due to a decrease in the density of the suction gas when the evaporator pressure is reduced from, say, 58 psi (60 F) for heating to 42 psi (45 F) for cooling.

Considering these advantages, the scheme appears to have certain possibilities. There is one factor, however, that places a definite limitation on the application. This limitation stems from the fact that there is a certain maximum distance beyond which the loop water cannot be circulated economically. As the size of the district or the number of dwellings to be served increases, the costs per dwelling associated with circulating the water increase, reaching a point where they offset the gains made possible with the application. Unfortunately, the limit is reached long before the number of dwellings begins to approach that which can be supplied with power from a single large modern power plant. Calculations show that the size of the plant should be of the order of 20,000 kw or less. The exact maximum size is influenced by many factors such as dwelling density, occupancy, heating and cooling loads, the layout of the district, and the location of the plant with respect to the center of the district.

Thus, in so far as utilizing waste heat from a very large station is concerned, the application must be confined to an area immediately surrounding the plant. Here, of course, the application is confronted with the trend toward larger and larger stations located remotely from highly populated districts.

In recent years, certain industries have found it either profitable or otherwise desirable to build factories complete with power plants in isolated sections of the country and along with this have erected sizable and modern housing projects, including shopping and entertainment centers, to attract workers to these factories. This is an example of a specialized case where the application may deserve consideration.

While there are special instances where waste heat from power plants or industrial processes can be used as a source of heat, the main concern in this paper is the case where the power plant is considered part of the housing project. The feasibility of the system must be predicated on whether all of the combined advantages result in lower total costs than are obtained for some other method of supplying equivalent comfort and convenience to those occupying the dwelling.

COMPARISON WITH EARTH AS A HEAT SOURCE

The best way to gain some idea of the practicability of the scheme seems to be to work out a specific example and compare the results with that of a heat pump using earth as a source of heat. The earth is chosen for comparative purposes because, of all the natural heat sources, it appears to offer the most promise as a universal source of heat.

For this example, a group of 1000 well-insulated dwellings, located in the vicinity of Cincinnati, Ohio, or in a locality having similar climatic conditions, has been chosen. The dwellings are conceived as all electric in that all energy-consuming domestic utility services are supplied by electricity. Each dwelling is equipped with a year-round air-conditioning heat pump. To simplify the calculations, it will be considered that the heat pump operates continuously on the coldest day of the year and that the thermostat will not be set back at night.

In the geographical area chosen, the annual heating requirement for a dwelling having an assumed maximum heat loss of 54,000 Btu per hr is approximately 96,000,000 Btu. The maximum cooling load is taken as 30,000 Btu per hr. With an assumed cooling load factor of 18 per cent over a 125-day period, the total annual cooling requirement is 16,000,000 Btu, or one-sixth of the total heating requirements.

Domestic service water is assumed to be heated by an immersion-type electric heater. For an estimated daily consumption of 55 gal of 140 F water, the monthly power requirement is 350 kwhr.

Power consumed for electric cooking, household refrigeration, lighting, and miscellaneous domestic appliances is estimated to average 220 kwhr per month.

Few reliable data are available on the continuous operation of earth heat pumps, but judging from the few which the authors have seen, it is apparently necessary to operate earth heat pumps at an average evaporator temperature of about 20 F during the heating season in order to insure a continuous and sufficient flow of heat from the soil. At the start of the heating season when the soil is warm, the evaporator temperature is fairly high, but it drops rapidly, leveling off at about 20 F until shortly after the peak load occurs and it may then drop to a temperature below 20 F. On the basis of this, Fig. 2 gives a cop (heating) of 2.9 and a heat-pump size of 5.0 kw. For the same load, a heat pump operating on condenser cooling water at 70 F (evaporator at 60 F) has a cop of 5.0 and a size of about 2.7 kw.

For summer operation, an evaporator temperature of 45 F is selected. The condenser temperature is estimated to average around 105 F for both the earth and group systems. Here again little is known about the earth, and this may favor the earth system somewhat, as temperatures up to 120 F have been given for some earth heat pumps. For the group system, the 105 F condenser temperature is based on cooling the loop water to 85 F in the spray pond and on a 20 F temperature rise in the loop, as shown previously. The calculated cop for summer cooling is 3.4.

Since the cop obtained from Fig. 2 does not include power for pumping the loop water, this must be determined separately. The pumping power varies within wide limits, depending on the size of the project, the dwelling density, the specific arrangement of the piping, and the location of the power plant with respect to the housing project. To determine the power for circulating the loop water, several hypothetical piping layouts were made.

Table 1 gives the essential details of the loop and of the pumping requirements for a 1000-dwelling project with the power plant located in the center of the project. To show the extent

TABLE 1 ESTIMATED POWER AND PIPING REQUIREMENTS FOR CIRCULATING LOOP WATER

1000 Dwellings With Power Plant Located at Center of Housing Project

	Single-family detached dwellings, 60 × 150-ft lots	Four-family-row units
Dwelling density, dwellings per acre	4	12
Piping, feet:		
4-in. pipe	58400[a]	20400[a]
6-in. pipe	1200	900
8-in. pipe	2800	2100
10-in. pipe	7600	2900
Total	70000	26300
Equivalent length of longest run, ft	10500	5100
Pressure drop per foot of equivalent length, milinches	300	300
Maximum flow at 20 deg F drop, gpm	5000	5000
Total head at maximum flow, ft	265	130
Maximum input to pumps, kw	370	180
Average input to pumps, per cent of maximum input	40	40
Annual power required for pumping, kwhr per dwelling	1300	650

[a] Wherever possible, the 4-inch pipe passes through the basements of the buildings.

of variation with dwelling density, both single-family and apartment-type projects are considered. In both instances, one-pipe systems are provided. The average power input to the pumps was based on a combination parallel-series pump arrangement and on maintaining a 20-F rise or drop in the loop temperature throughout the year.

As pointed out earlier, smaller housing projects require less pumping power per unit of heat delivered. For example, it is estimated that less than 700 kwhr per dwelling per year would be required for a 400-house project consisting of single-family dwellings, as contrasted with 1300 kwhr per dwelling for the 1000-house project.

Fig. 3 summarizes the power requirements as calculated for the two types of heat pumps. The figures for the group system are for single-family detached dwellings. In the case of the four-family-row units, the total power requirements would be 7650 kwhr and the over-all annual cop would be 4.3.

Several questions arise in connection with a power plant sized just to meet the demands of the housing project. One is: Is there sufficient heat in the exhaust steam to satisfy the heat-source requirements of the heat pumps? To find an answer to this question, heat-balance calculations were made of plants of 5000 to 10,000 kw capacity operating at pressures and temperatures of 875 psi and 825 F. These showed that, at 1.5 in. Hg back pressure, about 55 per cent of the heat in the fuel fired goes to the condensing cooling water, while 23 per cent is delivered to the dwellings, or that 2.4 Btu are available as a source of heat for each Btu delivered in the form of electricity. For a heat pump operating with a cop of 5 and delivering 54,000 Btu per hr, about 43,000 Btu per hr are absorbed in the evaporator; the rest comes from the heat of compression and losses recovered from the compressor and motors. The heat pump consumes 3.5 kw, including pumping, and the maximum coincidental demand[5,6] for the other electric load is about 2.1, making a total of 5.6 kw. The heat rejected to the loop water, then, is $5.6 \times 2.4 \times 3413 = 46{,}000$ Btu per hr plus about 1000 Btu per hr added by the pumps in overcoming the resistance to flow. Since 43,000 Btu are needed, a loop heat loss of about 9 per cent can be tolerated at the conditions of full load. Most of the time, however, the demand of the other services will be well below the peak of 2.1 kw. At times, especially at night, it may be as low as 0.3 kw per dwelling, in which case only $3.8 \times 2.4 \times 3413 = 31{,}000$ Btu per hr would be available. Throughout most of the heating season, this would be adequate because of diversity among the many heat pumps, but, during the coldest weeks of the year, some additional heat would be required. There are several ways in which this deficiency can be made up: (1) Auxiliary heating with low-pressure steam extracted from the turbine; (2) topping-up with electric strip heaters; or (3) taking on additional load, such as from a nearby shopping center, or street lighting throughout the development, for examples. The last, of course, would be the most desirable, whereas topping with strip heaters would be the least desirable. The use of low-pressure steam would, of course, reduce the over-all average thermal efficiency slightly.

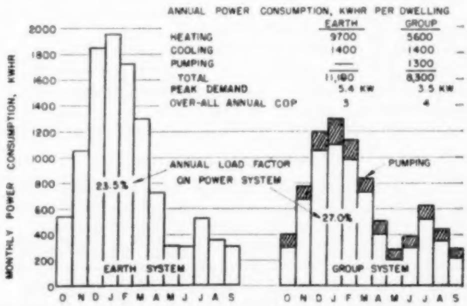


FIG. 3 COMPARISON OF POWER CONSUMED BY HEAT PUMPS USING EARTH OR 70-DEG-F CONDENSING COOLING WATER FOR HEAT SOURCE

Another question concerns the cost of generating power in a small plant. It must be recognized at the outset that power cannot be generated as cheaply in a small plant as it can in a large station where more efficient equipment and more extensive use of economizers can be justified, and where the labor factor and the investment per kilowatt of capacity are lower. On the other hand, with a small plant, there are no expensive transmission lines and substations with the accompanying power losses, and there are no selling expenses, since the project is conceived as all-electric from the beginning. Also, there is the improvement in the load factor on the power plant and the lower kilowatt demand on the distribution system, both of which are favorable to the small plant. Although the resulting savings might be substantial, it still is not foreseeable that a small plant can generate and distribute power as cheaply as large central stations.

A third question has to do with fuel conservation. In the future, conservation of the premium fuels now so widely used for space heating is certain to be of prime importance. In northern localities, heat pumps using the earth as a source of heat and as a heat sink have at present an average annual cop of about 3. When this is combined with a thermal efficiency of, say, 25 per cent in generating and distributing power, the over-all thermal efficiency for heating and cooling is 75 per cent, which is comparable with that derived from the best fuel-fired heating and cooling equipment. Present generating capacity is continually being replaced with more efficient plants, and it is possible that the average thermal efficiency may eventually reach 30 per cent. At the same time, continued research and development work on heat pumps is expected to increase the cop, so that we can look forward to an over-all thermal effi-

[5] "The Heat Pump—Its Significance as a Potential Residential Electric Load," by Constantine Bary, Trans. AIEE, vol. 68, 1949, part 1, pp. 1–8.

[6] "Determination of Diversified Residential Demands," by C. S. Alger, *Electric Light and Power*, vol. 24, January, 1946, pp. 76–79.

ciency approaching 100 per cent. This will be accomplished by burning low-grade coals, saving the premium coal and other fuels for other uses.

A group system having a plant-distribution efficiency of 23 per cent and a heat-pump cop of 4 to 4.3 results in an over-all thermal efficiency of 92 to 99 per cent for heating and cooling.

The real and proper comparison should include the power for other services. When this is done, on the basis of present-day operation, the result is as shown in Table 2.

TABLE 2 COMPARISON OF CALCULATED OVER-ALL THERMAL EFFICIENCIES OF SEVERAL SYSTEMS FOR SUPPLYING COMPLETE RESIDENTIAL UTILITY SERVICE

	Group system	Earth system	Fuel-fired heating and cooling
Energy delivered and used, million Btu per dwelling per year:			
Heating and cooling	112	112	112
Cooking, water heating, lighting, and miscellaneous	23	23	23
Total	135	135	135
Energy input, million Btu per dwelling per year:			
Heating and cooling	123[a]	152	152
Cooking, water heating, lighting, and miscellaneous	100	92	92
Total	223	244	244
Over-all thermal efficiency, per cent	60.5[a]	55.3	55.3

[a] Does not include auxiliary heat that may be required.

A discussion of this approach to the heat pump would not be complete without presenting cost figures; in the final analysis the over-all cost is the principal factor affecting the feasibility of the application, since there appears to be no serious engineering problem. The estimated costs, which are given here are believed to be reasonably representative, but they should not be construed to be final appraisals of the systems described. The heat pump is still a relatively new device, and the possibilities of reducing its cost through development work and mass production have not yet been fully developed.

Table 3 gives the estimated costs of the heat pumps. The $300 differential between the earth and group heat pumps is not so great as might be expected from the difference in size shown in Fig. 2. The reason for this is that the compressor and compressor motor, which are the most expensive components, must be selected from available standard sizes. Should standard sizes become available in smaller increments, greater savings in initial costs would be possible. The costs of the loop, pumps, and spray pond are based on a plant located at the center of the housing project. The total investment savings made possible by the use of condensing cooling water are $350 to $620, depending on dwelling density.

TABLE 3 ESTIMATED COSTS OF HEAT PUMPS AND EQUIPMENT FOR UTILIZING HEAT SOURCES

	Earth system	Group system, —1000 dwellings— Single-family detached dwelling	Four-family row (per family unit)
Heat pump	$2000	$1700	$1700
Ductwork	250	250	250
Loop, pumps, and spray pond	...	450	180
Ground coil	500	...	...
Total	$2750	$2400	$2130
Saving		$350	$620

Table 4 shows the method of estimating the cost of generating and distributing power to the 1000-dwelling project. Table 5 summarizes the power and investment costs.

TABLE 4 ESTIMATED COST OF SUPPLYING POWER TO 1000 DWELLINGS FROM A 7000-KW POWER PLANT

Peak diversified demand—5600 kw

Investment:	
Plant, 7000 kw at $190 per kw	$1,330,000
Distribution system, $200 per dwelling	200,000
Total	1,530,000
Annual fixed charges, 13.0 per cent of $1,530,000	199,000
Annual operating cost:	
Fuel = $\frac{(15{,}140{,}000 \text{ kwhr})(1.2 \text{ lb coal per kwhr})(\$9.00 \text{ per ton})}{2000}$	= 82,000
Operating labor, 13 men	42,000
Maintenance, 2 per cent of $1,530,000	31,000
Miscellaneous and supplies, 10 per cent of fuel cost	8,000
Administrative overhead, customer billing, and servicing	12,000
Total	$175,000
Total annual cost	$374,000
Total cost per kwhr, cents	2.5

TABLE 5 SUMMARY OF INVESTMENT AND ANNUAL POWER COSTS FOR ALL-ELECTRIC HOUSE IN A 1000-DWELLING HOUSING DEVELOPMENT

	Single-family detached dwelling Kwhr	Cost	Four-family row (per family unit) Kwhr	Cost
Power, 2.5 cents per kwhr				
Heating and cooling	8300	$207	7650	$191
Cooking, water heating, lighting, and miscellaneous	6840	171	6840	171
Total	15140	$378	14490	$362
Investment in heat pump and equipment for utilizing heat source		$2400		$2130

In the way of comparison, the earth heat-pump system requires a total of 17,940 kwhr per dwelling per year for all-electric service. The electric rate required for this system to equal the power cost of the group systems is 2.1 cents for the single-family dwellings or 2.0 cents for the multifamily units. If fixed charges on the investment in the heat pumps and associated equipment are included, and they should be for a true comparison, the equivalent electric rate for the earth system is less than 2 cents per kwhr. For example, with annual fixed charges figured at 10 per cent, rates are 1.9 and 1.7 cents, respectively, for the single-family and multifamily dwelling units.

The important conclusion to be drawn from these figures is that, with the use of condenser cooling water, the savings in power and in the initial cost of the heat pump are enough to offset a 0.6 to 0.8 cent differential in electric rate between the large and the small power plant. The allowable differential is somewhat greater for smaller-sized housing developments, owing to lower expense associated with circulating the loop water.

SUMMARY AND CONCLUSIONS

The main purpose of this paper has been to discuss use of the steam-generating plant as a source and sink for the heat pump in connection with the heating and cooling of groups of all-electric houses. The advantages and limitations of the application have been compared, using specific examples for clarity and as an aid in estimating the feasibility of the application.

The system described has many advantages over the use of natural heat sources, chief among them being:

(*Continued on page 564*)

MERCURY-STEAM POWER PLANTS

Current Operating Results and Developments in 1949–1950

By HAROLD N. HACKETT

KNOLLS ATOMIC POWER LABORATORY, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y. MEMBER ASME

THE continued upward trend of fuel and other operating costs is providing the impetus now apparent in the electrical power industry for the use of high-efficiency power cycles. Every effort is being made to produce a kilowatt-hour with the minimum expenditure of fuel and at the lowest possible cost.

Obviously then, power-generating units having a maximum over-all efficiency and of simple design and reasonable cost are being studied carefully by power-plant engineers in an effort to combat the rising cost of power.

The users of large-capacity, high-pressure, and high temperature-reheat units may readily secure power-generating plants that are relatively low in cost per kilowatt-hour of capacity and use a minimum of fuel. This situation is somewhat different, however, for power systems where steam-generating units of from 40,000 to 50,000 kw capacity and smaller are usually installed. Relatively large sacrifices in thermal efficiency and first cost are experienced, although simplicity of plant design may be retained readily. The probability of developing highly efficient, small-capacity, steam power plants is remote for various reasons. The mercury-steam cycle, however, does offer such possibilities.

Mercury-steam power-generating units of relatively small sizes are capable of producing electrical power at materially lower fuel rates per kilowatt-hour than steam plants of like capacity. In fact, the fuel rates of relatively small mercury plants are in most cases lower than the best steam plants of much greater capacity.

A comparison of mercury and steam plant net heat rates is shown in Fig. 1, and it may be noted that the 40,000-kw Schiller Station (1),[1] for example, using moderate pressure and temperature mercury-steam generating equipment, has a plant net heat rate that compares very favorably with the 100,000-kw Sewaren units (2) Fig. 1, items 8 and 9, and the 125,000-kw Philip Sporn No. 1 Unit (3) Fig. 1, items 7 and 7A. When compared with recently installed units of like capacity, the reduction in fuel consumption of the Schiller Station is in the order of 1300 Btu per net kwhr or approximately 12 per cent. However, a 40,000-kw mercury-steam plant, utilizing a single 15,000-kw mercury unit and a 25,000-kw steam turbine designed to operate at 850 psig 900 F, would be expected to show about 15 per cent improvement in fuel rate per kilowatt-hour, Fig. 1, items 3 and 17. Further study of Fig. 1 shows that in every case the mercury-steam power-plant heat rates are materially lower than those of steam plants of comparable size.

Plants 5 and 6 represent what may be expected from the mercury-steam cycle when designed to take full advantage of present maximum pressure and temperature conditions and relatively large capacity mercury and steam turbines. Such plants would be expected to produce electrical power for less than 8800 Btu per net kwhr when burning pulverized Eastern Bituminous coal. Materially improved over-all power-plant efficiencies for the lower-capacity mercury plants also may be secured by utilizing higher steam pressures and temperatures.

Definite progress has been made recently in the art of power generation by means of the applied mercury-steam cycle. Highly efficient, reliable, mercury power plants, requiring a minimum of operating personnel, are now in operation at Kearny, N. J., at Hartford, Conn., in the Pittsfield Works power station of the General Electric Company, and the Schiller Station at Portsmouth, N. H. These plants have been in operation for various periods of time from about one year for the Schiller Station to almost ten years for Kearny. All of these plants are considered as firm capacity and are operated as base-load units on their respective power systems because of their relatively high efficiencies and dependability. The 40,000-kw Schiller Station, for example, has a guaranteed plant net heat rate of 9200 Btu per kwhr when the fuel burned is bunker C fuel oil. This extremely low heat rate, for any-capacity station, we believe, establishes an all-time low value of fuel required for the production of a kilowatt-hour.

STATUS OF EXISTING MERCURY POWER PLANTS

General plant and design performance data for the various mercury plants is shown in Table 1. Of the six plants shown, two have been taken out of service and dismantled due to obsolescence.

However, three new mercury power plants, having a total generating capacity of approximately 92,500 kw, were placed in service in 1949 and the early part of 1950. Two of the mercury plants were topping units for existing steam turbines, while the third installation was a complete plant built on a new site for the purpose of generating electric power only.

Hartford Unit. The first of these plants to be placed in service was the 15,000-kw topping unit, installed in the South Meadow Station of the Hartford Electric Light Company as a replacement for the original 10,000-kw equipment previously installed in 1928 (4).

At maximum design rating, the new equipment will produce 15,000 kw of electric power from the mercury-turbine generator, and approximately 200,000 lb per hr of 400 psig 700 F by-product steam to supplement existing steam-boiler capacity.

The new unit was first fired January 1, 1949, and was declared to be in service one month later as firm generating capacity on the system.

The operation of this unit has been very satisfactory with only the minimum of design and operating troubles. As of

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Power Division and presented at the Spring Meeting, Atlanta, Ga., April 2–5, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

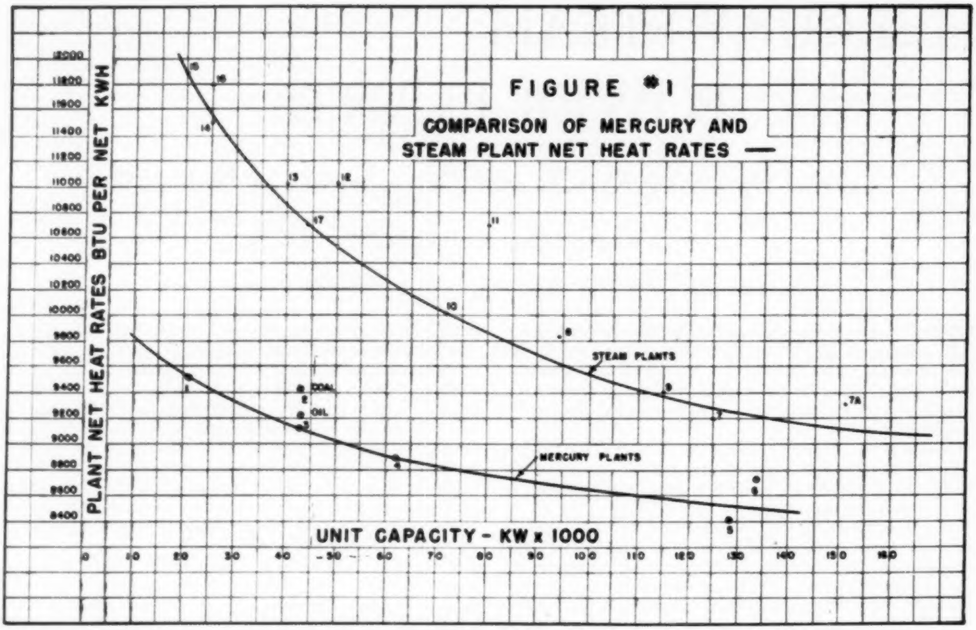


FIG. 1 COMPARISON OF MERCURY AND STEAM-PLANT NET HEAT RATES

(Relative plant net heat rates in Btu per net kwhr for mercury and steam plants over a range of sizes from 20,000 kw up to units in excess of 130,000 kw capacity.)

Point no.	Type of plant	Name of station
1	20,000-kw mercury-steam	Estimated
2	40,000-kw mercury-steam	Schiller Station
3	40,000-kw mercury-steam	Estimated
4	60,000-kw mercury-steam	Estimated
5	125,000-kw mercury-steam	Estimated
6	130,000-kw mercury-steam	Estimated
7	125,000-kw steam-reheat	Philip Sporn No. 1
7A	Sporn No. 1 at 151,000 kw	Philip Sporn No. 1
8	100,000-kw steam-nonreheat	Sewaren No. 1
9	115,000-kw steam-reheat	Sewaren No. 4

Point no.	Type of plant	Name of station
10	71,800-kw steam-reheat	Twin Branch No. 3
11	80,000-kw steam-nonreheat	Oswego No. 1
12	50,000-kw steam-nonreheat	Mystic
13	40,000-kw steam-nonreheat	White River Station
14	25,000-kw steam-nonreheat	Stamford
15	25,000-kw steam-nonreheat	Hudson Plant
16	25,000-kw steam-nonreheat	Black Hawk Station
17	40,000-kw steam-nonreheat	Estimated

midnight, September 30, 1950, covering an operating period of 15,312 hr, the total power produced by the mercury plant has been 319,962,000 kwhr. Of this total some 147,998,000 kwhr were generated by the mercury-turbine generator while the balance or 171,964,000 kwhr represent the power produced by steam-turbine generators from the 400 psig 700 F by-product steam. The power thus produced has been at an average heat input of 10,150 Btu per net kwhr. Because of the high over-all efficiency, the mercury unit is operated at base load and at approximately maximum rating continuously.

Pittsfield Unit. The 7500-kw mercury plant installation in the General Electric Company's Pittsfield Works power station was designed to generate approximately 113,000 lb per hr of 640 psig 825 F steam at a mercury-turbine output of 7500 kw per hr (5).

Preliminary operation started in August, 1949, and as of September 8, 1950, the equipment had operated for 6527 hr on the line and had produced a total combined electric-power output of 107,385,000 kwhr.

The plant is an excellent example of using the mercury-steam cycle to advantage where steam-turbine condensing facilities are limited and where the fuel costs are high as in the case of Pittsfield. Pittsfield Works added 7500 kw of extremely efficient capacity to the system without increasing the condensing load on an already overworked condensing-water system.

Schiller Station. The last unit to be placed in operation was the 40,000-kw mercury-unit power plant of the Public Service Company of New Hampshire at Portsmouth, N. H. This plant, known as the Schiller Station, is the most efficient 40,000-kw power-generating unit in America.

The power-generating equipment in the plant consists of two 7500-kw mercury turbine-condenser boiler sets, two radiant-type mercury boilers, and one 25,000-kw steam-turbine set. The mercury turbines operate at 105 psig, 934 F at the turbine throttle at the plant name-plate rating of 40,000 kw, while the steam-turbine throttle conditions are 600 psig 825 F.

The first mercury-turbine unit and the steam turbine were ready for operation in November, 1949. The second mercury unit was ready in January, 1950, and the plant was loaded at 40,000 kw gross generation on Jan. 17, 1950, for the first time.

TABLE 1 GENERAL PLANT AND OPERATING PERFORMANCE DATA FOR MERCURY POWER PLANTS[a]

	Item no	Hartford Electric Light Company, South Meadow Station 10,000-kw original unit	Hartford Electric Light Company, South Meadow Station 15,000-kw new unit	Public Service Electric & Gas Company, Kearny Generating Station	General Electric Company, Schenectady Works Mercury Steam Station	Public Service Company of New Hampshire-Schiller Station	General Electric Company, Pittsfield Works Power Station
	General plant data:						
1	Location of mercury plant	Hartford, Conn.		South Kearny, N. J.	Schenectady, N. Y.	Portsmouth, N. H.	Pittsfield, Mass
2	Mercury power-plant rating, kw per hr	10000	15000	20000	20000	40000	7500
3	Steam output, lb per hr	124000	210000	290000	325000	0	124500
4	Mercury-turbine throttle conditions, P, F	85_p, 883 F	130_p, 947 F	140_p, 958 F	140_p, 958 F	122_p, 944 F	128_p, 944 F
5	Steam conditions, superheater outlet, P, FTT	400_p, 700 FTT	400_p, 750 FTT	380_p, 750 FTT	415_p, 750 FTT	615_p, 825 FTT	640_p, 825 FTT
6	Types of applications	Central station		Central station	Industrial	Central station	Industrial
7	Types of service	Base load		Base load	Mfg. load	System load	Mfg. load
8	Types of fuel burner	Fuel oil		Pulv. coal and fuel oil	Pulv. coal	Pulv. coal and fuel oil	Pulv. coal and fuel oil
9	Date mercury plant placed in service	1928	1949	1933	1933	1949	1949
10	Status of plants	Dismantled—1947	Operating	Operating	Dismantled—1949	Operating	Operating
	Mercury-plant performance data:						
11	Mercury-boiler-drum outlet conditions	100_p, 907 F	145_p, 964 F	155_p, 975 F	155_p, 975 F	135_p, 953 F	143_p, 962 F
12	Mercury-turbine throttle conditions	85_p, 883 F	130_p, 947 F	140_p, 958 F	140_p, 958 F	122_p, 937 F	128_p, 944 F
13	Quality of mercury vapor	Dry and saturated	Dry, saturated	Dry, saturated	Dry, saturated	Dry, saturated	Dry, saturated
14	Mercury-turbine exhaust conditions, P, F	1.38_p, 478 F	1.5_p, 485 F	1.3_p, 475 F	1.23_p, 471 F	2.13_p, 508 F	2.80_p, 530 F
15	Mercury-turbine throttle flow, lb per hr ea.	1080000	1640000	2200000	2143000	938000	987000
16	Number of mercury turbines per plant	1	1	1	1	2	1
17	Number of mercury boilers per plant	1	1	1	1	2	1
18	Mercury-turbine generator rating, kw per hr at 0.8 PF	10000	15000 (1.0 pf)	20000	20000	7500 (each)	7500
19	Steam-turbine generator rating, kw per hr at 0.8 PF	....	.....	....	....	25000	....
20	Quantity of steam produced by mercury plants lb per hr	124000	210000	300000	325000		124500
21	Steam-turbine throttle conditions, P, FTT	400_p, 700 FTT	400_p, 700 FTT	380_p, 750 FTT	Steam piped to factory for process and other uses	615_p, 825 FTT	640_p, 825 FTT
22	Steam-turbine generator output, kw per hr	E 12400	E 19100	E 25000			Steam piped to existing station steam header
23	Total combined plant generation, kw per hr	E 22400	E 14100	E 45000		40000	
24	Mercury-plant auxiliary requirements, kw per hr (includes steam-turbine auxiliaries where required)	600	900	2000	1750	1500	900
25	Mercury-plant combined net output, kw per hr	21800	33200	43000		38500	
26	Mercury-plant fuel requirements, but × 10 per hr	232.0	334.0	450.0	500.0	360.0	203.0
27[a]	Total kwhr, generated, actual or equivalent	1724440686	319962000	3105453000	1683786718	171429700	107385000
28	Service hours	119082½	18312	86603	65180	7086	6527

[a] Total kwhr based on actual mercury-turbine kwhr output plus equivalent kwhr from steam generated, except for Schiller Station which is actual total generation from mercury and steam-turbine units.

Note: E, equivalent; F, saturated temperature; FTT, final total temperature after superheating; P, pounds per square inch absolute.

This tabulation gives pertinent design and performance data for the various mercury power plants that have been built in the United States. These plants as of midnight September 30, 1950, have been operated a total of 302,790.5 hr on line, and have generated a total of 7,112,457,104 kwhr of electrical power and equivalent steam.

The plant operates regularly at base load of 46,000 kw per hr at a gross heat rate of about 9100 Btu, but, at the guarantee gross output of 43,170 kw, the power is produced at a heat input of slightly over 9000 Btu. When corrected for station auxiliary power, the fuel required is in the order of 9400 Btu per net kwhr. There is every expectation that the plant will meet its heat rate of 9200 Btu per net kwhr when the equipment is operated at design conditions.

PROGRESS DEVELOPMENTS

During the design and preliminary operating periods covering the three new mercury plants, a number of important problems were encountered. For various reasons, many of these problems had not been encountered previously and therefore opened entirely new fields for engineering study and operating procedure. Some of the more important of these problems developed in the studies of how to start, stop, and load the station-generating equipment, or how to control the mercury liquid feed to the mercury boiler.

Many other problems of physical support, expansion allowances, tube-temperature measurements, and liquid circulation arose in connection with the design and building of the large radiant-type mercury boilers. Likewise, the entirely new vertical-type condenser boilers, having extremely small steam-release areas developed unexpected solids carry-over problems of an annoying nature.

How these and many other unique problems were solved could provide material for other papers and, because of space limitations, cannot all be discussed here.

However, because of the somewhat unusual operating conditions expected at the Schiller Station, in particular, the author will endeavor to describe as briefly as possible the method of load control utilized in this plant, as well as indicate how load control is accomplished at the Hartford, Kearny, and Pittsfield mercury plants.

LOAD-CONTROL PROBLEMS

Hartford and Kearny. Controlling the electrical or steam output of mercury topping plants such as the Hartford and Kearny units is simple as these units are normally operated at base load at or near maximum design output. In each case the mercury-turbine stop and control valves are in the wide-open position, thereby allowing the mercury-vapor pressure to vary with the load. Likewise, the plant fuel requirements are a direct function of the load and are regulated manually to maintain the desired electrical output of the mercury-turbine generator.

Pittsfield. The 750-kw Pittsfield unit is operated in a manner similar to the Hartford and Kearny units except that the variation in load demands due to manufacturing requirements varies from a minimum of some 2000 kw to full output each day or at most each week. The vapor pressure is allowed to vary with the load while the fuel demands may be satisfied either by means of manual control or by automatic combustion control as desired.

Schiller Station. Load control in the Schiller Station is not as simple as in the other mercury stations because of the number and types of turbines involved. At Schiller Station it is necessary to start, stop, load, or unload an integrated power-generating unit, consisting of two 7500-kw mercury-turbine units and one 25,000-kw condensing steam turbine. The steam turbine must be in service at all times, although either one or both mercury units may be operated as desired.

All of the 600-psig steam required to drive the 25,000-kw steam turbine, as well as for a limited number of steam-turbine-driven emergency auxiliaries, may be supplied only by the mercury-condenser boilers, as no other source of primary steam is available. This situation does not offer any particular problem, although it is necessary always to start one of the mercury units before the steam turbine can be put in service. Early studies of the mercury-turbine and steam-turbine performance figures indicated that the steam produced from one set of (two) mercury-condenser boilers would be sufficient to drive the steam turbine at synchronous speed when the kilowatt output from the mercury turbine was some 200 to 300 kw. It was further predicted that one mercury unit could be fired off, the turbine started and brought up to speed, and synchronized with the system before the condenser-boiler steam pressure reached 600 psig.

These predictions proved to be correct when the units were placed in service as the actual normal starting cycle of the station from dead cold to "on line" is a matter of about $13^1/_4$ hr. The various detailed operations of warm-up, initial rolling of the turbines, and so forth, described in more detail later, are set forth in Table 2.

TABLE 2 STARTING AND LOADING TIME CYCLE ALSO SHUTTING-DOWN TIME CYCLE—SCHILLER STATION

	First Hg unit	Steam unit	Second Hg unit
Start evacuating mercury-vapor system	00:00	11:00	03:00
Firing-off mercury boilers	04:00		07:00
Roll turbines	09:00	11:10	12:00
Synchronize turbine generator	10:15	12:30	13:15
Minimum load	12:15		14:15
Rated load (maximum)	13:45	15:45	15:45
Start unloading plant	00:00	00:00	00:00
Off line	03:30	03:30	03:30
Break vacuum	08:00	03:35	08:00

NOTE: This tabulation shows starting, and loading, and shutting-down time cycles for the three generating units in the Schiller Station. Mercury-condenser boilers are the only source of primary steam in the station, and it is, therefore, necessary to have one or both 7500-kw mercury units in operation before 600-psig steam becomes available for starting or loading the 25,000-kw steam turbine.

METHODS OF FREQUENCY AND LOAD CONTROL

Several methods of frequency and load control were provided for because of the unusual combination and functions of the three main generating units. The controls may be made a function of mercury-turbine throttle pressure, they may be a function of the steam-turbine throttle pressure, they may be a function of the system frequency, or a function of certain combinations of these.

It was anticipated that all of these situations might be expected during the life of the plant, therefore, frequency and plant-loading control devices were supplied so that each type of operation could be used as future conditions might dictate. Complete automatic combustion-control equipment was provided subsequently and arranged to operate under each of the anticipated conditions.

Frequency Control. It was further assumed that Schiller Station might be called upon to maintain frequency, especially if the plant should become isolated from the system for one reason or another. In order to be prepared for such emergency, several possible operating arrangements were studied and the following method adopted as being most suitable:

The two mercury turbines are normally operated on open throttle, allowing the mercury-vapor pressure and flow to vary with the station load. The station frequency would be held by the steam-turbine governor while the automatic combustion control would be actuated to maintain steam-turbine throttle pressure. The mercury turbines would follow the steam turbine by means of their generator electrical ties.

Load Control. When the station is operating under expected normal conditions, loading of the plant may be accomplished by operating the two mercury turbines with their control valves

in the wide-open position, with the steam-turbine steam-pressure regulator in service, and with the steam-turbine speed governor set on the high-speed stop. Station-load demands are then a function of the steam-turbine throttle pressure only and not a function of the system frequency. With all turbine speed governors thus on their high-speed stops, the actual plant output is directly proportional to the heat input from the fuel burned, regardless of the system power demands. The combustion-control equipment would be set to hold mercury-turbine throttle pressure.

Starting, Stopping, and Loading the Schiller Station. The actual starting, stopping, or loading of the Schiller Station proved to be extremely simple even though the particular combination of generating units is unusual. No primary steam for starting the 25,000-kw steam turbine can be made available, except as produced by one or both of the 7500-kw mercury units. Careful studies made during the early design stages of the plant indicated that no difficulties would be experienced in a normal starting-up cycle if proper time cycles and procedure cycles were followed. These earlier studies proved to be quite accurate because when the plant was finally placed in operation, the normal starting, loading, and shutting-down cycles followed very closely the predictions previously made.

Either one or both mercury units may be fired off together, although an elapse of about 3 hr between the actual firing of each boiler is normally followed. This period between the firing of the two units eliminates the possibility of having all three turbines ready to synchronize at exactly the same time.

STARTING AND LOADING TIME CYCLES

The time cycle now in use for starting and loading the three generating units at Schiller Station covers a total elapsed period of approximately $15^3/_4$ hr, including the evacuation period for the mercury units. This total of $15^3/_4$ hr is divided into several more or less specific operations. Each of these operations will now be discussed briefly as though applying to one of the mercury units only. However, the various steps described should be followed in proper sequence on the second mercury unit as indicated in Table 1 so that, by the time the first mercury unit and the steam-turbine unit are on line, the second mercury unit may be ready to "phase in" and load with the other machines as desired.

First Operation—Evacuating Mercury System. The mercury-vapor spaces of the mercury boiler, mercury turbine, and condenser boilers of each mercury unit are evacuated to not more than 0.5 in. mercury pressure absolute by means of mechanical air-removal pumps. This pumping-down period requiring about 4 hr is very important, as the operator may thereby determine the tightness of the vapor system by comparing the measured rate of air or other gases removed per hour with previously established evacuation curves. Should an air leak be indicated by excessive air-removal measurements, necessary corrections may be made before the unit is fired off, thereby avoiding a subsequent outage.

Second Operation—Warming-Up Mercury Boilers. When the conditions of the "first operation" have been satisfied, the mercury boiler may be "fired-off" and the fuel consumption maintained at rates necessary to warm up the mercury boiler and to generate mercury vapor at about 25 psig, in the mercury-boiler vapor drum. This warming-up cycle, Table 2, usually requires about 5 hr, although in periods of extremely cold weather, somewhat longer time may be required.

Third Operation—Starting and Rolling the Turbines (the first mercury turbine). During the boiler warm-up period, it is usual to also warm up the mercury turbine by allowing a small quantity of mercury vapor to pass through the turbine stop and control valves. Care is exercised not to pass sufficient mercury vapor to start the mercury turbine until desired.

After the mercury-boiler pressure reaches 25 psig or so, the turbine is started and rolled for $^1/_2$ hr at 300 rpm. Synchronous speed of 1200 rpm is reached at the end of 1 hr total time. The turbine generator is then ready to phase-in preparatory to loading.

Overspeed trips and such are checked prior to synchronizing the generator.

Fourth Operation—The Steam Turbine: Because of necessity, the steam turbine cannot be started until primary steam becomes available from one or both mercury units as the mercury-condenser boilers are the only source of high-pressure steam in the station. For this reason it is essential that at least one of the mercury units be fired off and the mercury-turbine generator synchronized with the electrical system. A firing rate is then established to provide sufficient exhaust mercury vapor to generate steam in the mercury-condenser boilers for starting, rolling, and synchronizing the 25,000-kw steam-turbine unit. From Table 2 it will be seen that this time cycle requires about $12^1/_2$ hr.

The Second Mercury Turbine: The second mercury turbine unit should be ready for synchronizing with the system about $^3/_4$ hr later.

Definition of Minimum Loads: Stable circulation in the mercury boilers occurs at a mercury-turbine generator output of something less than 2000 kw each. In order to retain safe operating margins, the minimum operating load for each mercury-turbine generator has been established to be not less than 2000 kw gross generation per hr or 4000 kw per hr for the two mercury units. The 600-psig by-product steam thus produced is sufficient to generate an additional 6000 kw from the steam-turbine generator, making the total minimum gross generation 10,000 kw per hr with all three turbines in service, and 5000 kw when only one mercury turbine and the steam unit are operating.

Fifth Operation—Load Plant to Minimum Load. As soon as one mercury unit and the steam unit are on line, they may be loaded to minimum load of 5000 kw within 15 to 30 min as desired.

When the second mercury turbine is being brought along in close sequence with the other units, it may likewise be brought up to minimum load following a time cycle similar to that established for the first mercury unit.

When the plant is ready to load, the mercury-turbine control valves are positioned in the wide-open position thereby allowing the vapor pressure to vary with the load. Fuel requirements are then regulated as a function of mercury-turbine throttle pressure either manually or by automatic combustion control.

Sixth Operation—Loading Plant to Rated Loads. After a mercury unit and the steam unit or both mercury units and the steam turbine are on line, they may be operated indefinitely at minimum load or the load may be increased to any desired value within the design capabilities of the equipment in service.

By placing the steam-turbine initial-pressure regulator in service to control throttle steam pressure, and with the steam-turbine control valve likewise in the wide-open position, the station may be operated at any desired load without interference from system load fluctuations. This arrangement provides satisfactory operating conditions as station-load changes then are a function of fuel input only.

Should the plant become suddenly isolated from the system, all machines would continue to operate on their high-speed governor stops until again brought to synchronous speed by the station operator. With all three turbines in service, the established rate of load increase for the plant is at a gross rate of 1000 kw every 4 min from minimum load of 10,000 kw to 46,000 kw. However, with only one mercury and the steam

turbine in operation, the scheduled rate of load increase is at one half the foregoing rate up to 22,000-kw gross plant generation.

Seventh Operation—Reducing Load. Normal load reductions are made at the same rates as for load increases. This conservative schedule was adopted because of the base-load nature of the plant, and the resulting ample time for anticipating station-load changes.

Eighth Operation—Off Line. When it is desired to take one of the mercury units or the entire plant off the line, the load on that unit or the plant, as the case may be, is reduced by the scheduled rates until minimum load is reached. The fire or fires are then put out and, when each generator output drops to zero, that generator is taken off the line and the turbine allowed to come to rest in the usual manner.

Ninth Operation—Breaking Vacuum. Vacuum is held on the mercury units until the temperature of the liquid mercury in the boiler drops to about 400 F, and then the mercury in the boiler is drained into the mercury storage tanks. The mercury-system vacuum is broken by filling the entire vapor spaces with tank nitrogen until atmospheric pressure is reached. Nitrogen flow is continued for the remainder of the cooling-down cycle.

CONCLUSION

The successful outcome of three new mercury plants has again demonstrated the practicability and economy of the mercury cycle and that it may be applied wherever desired or wherever economically justified. There are numerous types of applications where the mercury-steam cycle may be used to advantage although most applications usually come under four general types, as follows:

Type 1. Complete condensing plants where only electrical power is produced as at Schiller Station. Suggested nominal plant capacities would cover the range of from 12,500 kw to 130,000 kw with expected fuel input rates of from 10,500 Btu to some 8800 Btu per net kwhr from the smaller to the larger sizes.

Type 2. Topping plants for topping existing steam-generating units where (*a*) additional electrical generating capacity is required in addition to supplying high-pressure steam to existing steam turbines. The Hartford and Kearny mercury units are typical examples of the so-called topping plant. (*b*) Where additional electrical power and process steam is required for factory process work or for supplying low-pressure steam for central heating systems, and electrical power for general distribution.

Type 3. Mercury-plant installations where an acute shortage of important facilities exists, such as, (*a*) deficiency of condensing water as at Pittsfield; (*b*) insufficient steam-boiler capacity and demand for additional electrical generating capacity as existed at Hartford, Kearny, and Pittsfield.

Type 4. For the rehabilitation of otherwise obsolete steam-generating plants where (*a*) inefficient or obsolete and defunct steam boilers require replacement; (*b*) where it is desired to increase the over-all power-plant efficiency to the maximum; (*c*) where it is desired to increase the plant efficiency, and at the same time add the maximum amount of topping capacity.

Areas of high fuel costs obviously offer the most fertile fields for exploitation of the mercury cycle because of the appreciable reduction in yearly fuel requirements. These fuel-cost savings in many cases are in excess of 30 per cent, thereby making the application of the mercury-steam cycle extremely attractive.

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Steam-Generating Station as a Source and Sink for the Heat Pump

(Continued from page 558)

1 A heat source is provided that can be controlled within close temperature limits and that is not affected by climate, location, or legal restrictions.

2 A suitable heat sink is provided.

3 A much higher over-all annual coefficient of performance is obtainable.

4 A smaller size of heat pump is required in localities where the maximum heating load is greater than the maximum cooling load.

5 The annual load factor on the power system supplying the housing project is improved.

The principal limitations are as follows:

1 Because of pumping costs, the size of the housing development that can be served economically by the system is far below that which can be supplied with power from a large modern power station. Decentralization of generating capacity is therefore a necessary feature of the system.

2 To fulfill the heat-source requirements of the heat pumps with heat in the condenser cooling water alone, the total load on the power plant must be at least 1.6 times the power consumed by the heat pumps. The load imposed by all-electric houses meets this condition during most of the heating season, but additional load, or supplementary heating, is required during the coldest weeks of the year.

Translated into costs, which are compared with those of a system using the earth as a heat source and heat sink, the advantages result in an estimated saving in investment in the heat pump of 13 to 23 per cent. The operating cost is about the same where the small plant supplying the group system can generate and distribute power at an electric rate 0.5 cent above that which can be delivered by a large modern power station.

ACKNOWLEDGMENT

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SHOTPEENING *as a* FACTOR *in the* DESIGN *of* GEARS

By JOHN C. STRAUB

AMERICAN WHEELABRATOR & EQUIPMENT CORPORATION, MISHAWAKA, IND.

INTRODUCTION

WHEN a pair of gears is required to operate at high loads or high speeds or both, particularly in cases where weight and size are at a premium, it becomes important to consider shotpeening in the design. The greater the required horsepower per pound of transmission equipment, the more vital becomes the design of the gears which will be called upon to do the job. There is no intention of minimizing the importance of the other factors which go to make up a set of gears with high load-carrying capacity. Any significant shortcoming in forming the gear blanks, machining the teeth, control of material, heat-treatment, and the like, can nullify completely the advantages of an excellent design. Any confidence which the gear designer may have in the satisfactory operation of the gears which he has designed presupposes good manufacturing practice. This paper is concerned primarily with the design of the gear teeth themselves, particularly on spur and helical gears.

TYPES OF FAILURE IN GEAR TEETH

In general, gear-tooth failures may be grouped into three classifications:

1 Tooth breakage; this type of failure, in which an entire tooth or large portion of a tooth is broken out, is due to bending stress and is commonly known as a "fatigue" type of failure.

2 Pitting; this type of failure is characterized by pits or small craters in the contacting surface of the tooth. It is usually found on the pinion tooth at or somewhat below the pitch line. This is also a fatigue type of failure.

3 Scoring; this type of failure, sometimes referred to as spalling, scuffing, or galling, is distinctly different from the first two mentioned and is evidenced by a decided roughness on the working-tooth flank as though the mating surfaces had seized. As a matter of fact, it is generally accepted that scoring is actually the result of welding the two surfaces together and then tearing them apart. It is caused by high compressive stress, in combination with high sliding velocity of the tooth surfaces upon each other. Whereas bending and pitting failures are most likely to occur after a considerable amount of service, scoring is most likely to occur in the early stages of operation, if at all.

A pair of gears may be subject to any one or all of the foregoing types of failure, depending upon the type of service. In some cases this may result in a compromise between bending strength on one hand and scoring resistance on the other, because in some respects a design factor may favor one at the expense of the other. However, in highly stressed gears, scoring resistance may be increased by proper design consideration which utilizes greater bending strength.

It should be mentioned that in highly stressed gears, that is, gears which are required to transmit high horsepower with minimum weight, a good design is not necessarily obtained by even the most careful study of the problem from the standpoint of pure mechanics and strength of materials. In a simple beam, in which the exact magnitude and location of the load are known, it is a relatively simple matter to determine such factors as the maximum deflection, the bending moment, and nominal stress within reasonable accuracy.

When dealing with a pair of gears, however, we have an entirely different situation. It is true the geometry of gear teeth has been developed carefully and accurately, and, where necessary, gears are made with a high degree of precision. But when a pair of gears is mounted in a housing and the service load applied to the shaft, it is far from an easy problem to determine with any degree of accuracy the distribution of the load on the teeth, even though the laws of mechanics are considered most carefully, unless we have at our disposal sufficient test data to indicate what the distribution of load on the teeth is likely to be.

BENDING STRENGTH

In computing the bending strength of a pair of gears, one of the first questions that arises concerns the load on the teeth. Since a mathematical analysis does not yield a direct answer, another possibility is to assume that the transmitted load is distributed on the teeth in a somewhat logical manner. But there are several ways in which the load might be distributed on the teeth. For example, it might be assumed that the teeth are perfectly formed, perfectly spaced, and perfectly concentric. It may be further assumed that the deflections of the housing, bearings, and shafts are perfectly symmetrical. If these assumptions are correct, it would follow logically that the maximum bending stress in a tooth occurs at that point in the tooth action at which one tooth carries the entire transmitted load at the highest point on its profile, or the greatest distance from the root. Since we assumed in the beginning that the gears are perfectly symmetrical with respect to each other, it will follow logically that if these conditions exist even while the gears are transmitting load, the load carried by one tooth is distributed uniformly over the entire length of that tooth.

On the basis of the foregoing assumption, the problem appears to be well defined and not at all difficult. However, we must remember that this entire line of reasoning started out with a number of assumptions. It would have been just as logical had we assumed that the teeth are not perfectly formed, that they are not perfectly spaced, that they are not perfectly concentric, or that the deflections are not such that the mating gears are perfectly aligned while transmitting the load. Any one of these deviations from the original set of assumptions is likely to offset seriously the accuracy of our conclusion as to how the load is carried on the teeth.

How then are we to know the distribution of the load, and, therefore, to compute the load-carrying capacity of the teeth? One way would be to make extensive measurements and computations on actual sets of gears under load. But this is a tedi-

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ous and expensive procedure even for one set of gears, and, when the job is finished, it tells us nothing of the conditions which may exist in another design, or for that matter even in the same design mounted in a different housing.

Another way would be actually to test a large number of gears of different designs and different load-carrying capacities under conditions as nearly as possible like those obtained in actual service for which the gears have been designed. With complete data on the test procedure, cycles to failure, and design information, provided there are sufficient test data, the results can be analyzed statistically. This latter is the one which was used in selecting the method of bending-stress calculation involved in this discussion.

The procedure used in this selection was as follows: Data were obtained direct from different manufacturers on a large number of dynamometer fatigue tests on spur and helical automotive-type transmission gears. Complete information was obtained on the design and test results of each pair of gears.

A number of methods of stress computation were then set up, each on the basis of a different set of assumptions. In order to determine which, if any, of these methods would give consistent results, a "stress" value was computed for every gear included in the tests. The stress values obtained by each method were plotted on a log-log chart against the average number of cycles at which fatigue failure occurred.

As we would expect, some of the methods of stress calculation were immediately disqualified by the fact that no consistent relationship was thus obtained between the stress, as calculated, and the fatigue life from the test data. The results as calculated from other methods, however, did show a definite relationship between the calculated stress values and the average fatigue life from the test data, and it was not a difficult matter to select that method which showed the most consistent relationship.

There is no intention to imply that the method selected, or any other method of stress computation, based on the gear design, is capable of predicting exactly the life of a pair of gears under a given load. Anyone who is familiar with the characteristics of fatigue failure will realize that supposedly identical units of a given machine part, tested under identical conditions, are subject to a considerable variation in fatigue life. Such variations are inevitable in fatigue failure, regardless of the shape or accuracy of the parts involved. However, this inevitable variation in fatigue life need not be a source of discouragement, because by using the average results from a variety of designs, the influence of the design factors can be determined with reasonable accuracy.

Finally, the method of calculation which was selected, according to the procedure outlined, was based on the assumption that the load is distributed uniformly on the average total length of contact lines. The tooth-strength factor, commonly known as the "X-factor," is obtained from a layout in the section normal to the tooth, with the load applied at the tip of the tooth in the same manner as originally described by Wilfred Lewis. A complete description of this method of calculating bending strength was published some years ago (1).[1]

An appraisal of the effectiveness of this method can be obtained from the chart in Fig. 1 (reference 1), which shows the relationship between the stress number as calculated and the average life of the gears as determined by the dynamometer tests. Included in the chart are 155 tests on a variety of designs.

All of the tests, represented in Fig. 1, were made on gears of approximately 60 RC surface hardness, with no surface treatment other than the heat-treatment itself.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

By the use of this method, the design of a proposed pair of gears can be analyzed, and in some cases an appreciable gain in fatigue strength can be obtained by changes in the tooth proportions. For example, the requirements might permit a decrease in the diametral pitch or an increase in pressure angle, either of which would decrease the bending stress.

It is quite evident, of course, that any strength calculation cannot be expected to overcome poor manufacturing practice. There are numerous factors in processing which can affect the life of the gears seriously. One such factor is the nature of the tooth fillet, with regard to stress concentration resulting from deep toolmarks. Deep grooves in the tooth fillet can be more serious than the stress concentration due to the fillet itself. To minimize this condition it is good practice to use a chamfer, or better still, a rounded corner on the hob or cutter.

Since the method of calculation is based on average test results, a particularly good manufacturing procedure is likely to give better results than indicated by the average line.

The validity of a method of calculation of bending strength on automobile spiral-bevel-gear teeth was established some years ago (2) on the same basis as that described in the foregoing for spur and helical gears. It is interesting to note that these two methods differ sharply with regard to the assumed load distribution as well as the section in which the layout is made. Each method agrees very well with test results of gears of the type in question, but neither is valid for the other type.

SHOTPEENING FOR INCREASED STRENGTH

In gears which are intended to carry high stresses, a pronounced increase in fatigue strength can be obtained by shotpeening (3, 4, 5) the teeth. This is a process which is becoming more widely used as its advantages become more fully understood.

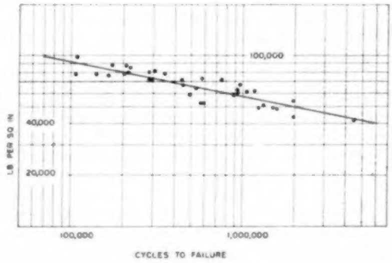


FIG. 1 FATIGUE CHART OF 155 HELICAL AUTOMOBILE TRANSMISSION GEARS USING PREFERRED METHOD OF CALCULATING TOOTH STRESS

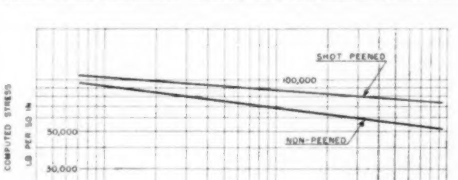


FIG. 2 FATIGUE CHART OF CARBURIZED AUTOMOTIVE-TYPE SPUR AND HELICAL GEARS, SHOTPEENED AND NONSHOTPEENED

It is an established fact that shotpeening is very effective as a means of increasing fatigue strength. Its effectiveness in overcoming fatigue failures in a given design of a machine part is well known. But its advantages in designing for greater fatigue strength and greater utilization of material are often overlooked. The increase in allowable stress for a given fatigue-life requirement will vary with that life requirement, that is, the greater the required life, the greater will be the benefit derived from shotpeening. However, even under severe requirements, an increase of 10 per cent in allowable stress is conservative.

Fig. 2 shows a fatigue line similar to that in Fig. 1, based on the same method of calculation, but from considerably more data than those originally accumulated. The lower line is comparable to that in Fig. 1 except that it represents carburized gears only and is somewhat higher. The original data in Fig. 1 included carburized gears as well as through-hardened and cyanided gears and, although the test points for the through-hardened gears were somewhat lower than for those which were carburized, there were not sufficient data at that time to distinguish between these two groups. More recent data on carburized gears have indicated that there is a distinct advantage in carburized gears as compared to those which are through-hardened and cyanided. Therefore it would be expected that results on through-hardened gears would fall below the average line. The actual test points have been deleted in Fig. 2 for the sake of clarity.

The upper line in Fig. 2 shows the average life in relation to the calculated stress for shotpeened carburized gears. In all cases, peening was the last operation in so far as the teeth are concerned, and no attempt was made to protect the tooth flanks from the blast.

A chart similar to that in Fig. 2 was recently published by J. O. Almen (6), which shows the lines for carburized gears, peened and nonpeened at a somewhat higher stress. This is due to the fact that the lines in Almen's chart are chosen to represent higher quality of manufacture. The lines shown in Fig. 2 represent a conservative average of the same test data along with additional data accumulated by the author on carburized gears, peened and nonpeened.

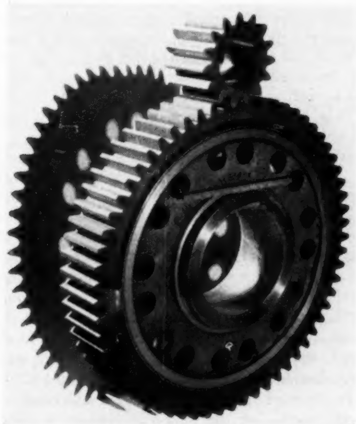


FIG. 3 LOCOMOTIVE DRIVE GEARS SHOTPEENED IN REGULAR PRODUCTION

(Courtesy Electro Motive Division, General Motors Corporation.)

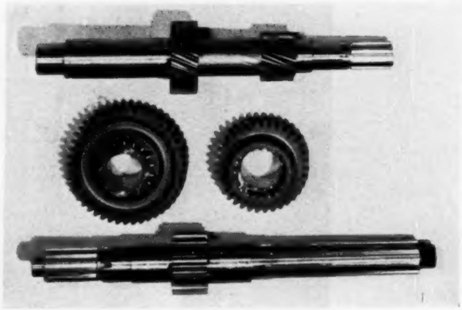


FIG. 4 HEAVY-DUTY TRUCK TRANSMISSION GEARS SHOTPEENED IN REGULAR PRODUCTION

(Courtesy Fuller Manufacturing Company.)

It can be seen from the chart that, for example, an average life of 800,000 cycles is obtained on nonpeened gears at a calculated stress of 71,000 psi. For the same average life, the allowable stress for shotpeened gears is 88,000 psi, or an increase of more than 24 per cent in allowable stress.

Looking at the chart from the standpoint of increase in life at a given calculated stress, it can be seen, for example, that at a calculated stress of 80,000 psi, the average life of nonpeened gears is 300,000 cycles, and that of shotpeened gears 3,000,000 cycles, or an increase of 1000 per cent in life.

Shotpeening is equally effective on gears of lower hardness as well as other types of gears, such as spiral bevel, hypoid, and so forth. Sufficient data are not available for stress-life charts on the other types, but an increase of 10 per cent in allowable stress is quite conservative.

In most cases, shotpeening is the last operation in so far as the teeth are concerned. The slight roughening of the surface of the tooth flanks has no detrimental effect. Actually, some manufacturers feel that shotpeened gears are more quiet-running than nonpeened gears of the same design and manufacture.

In some cases, however, it is desired to have a smooth finish on the tooth flanks. This can be accomplished by cutting the teeth with a protuberance hob, which produces an effect similar to undercutting at the root of the tooth. The gears are then hardened, shotpeened, and ground. This procedure allows the tooth flanks to be ground without removing any of the shotpeened surface in the fillet where the bending stress is maximum.

Fig. 3 shows an example of large gears which are shotpeened in regular production. These gears are used in a railroad application. Fig. 4 is an example of smaller gears used in heavy-duty truck transmissions, also shotpeened in regular production. These are representative of many applications in which shotpeening is considered by the manufacturer as an important part of the production processing.

Fig. 5 illustrates a machine used for shotpeening gears in production.

PITTING RESISTANCE

Data on pitting resistance are not as plentiful as is the case for bending strength, primarily because of the difficulty in obtaining quantitative data. Bending failures can be recognized easily while the gears are running, because of the sudden noise. Pitting, on the other hand, is a very slow and progressive failure, starting with extremely small craters in the tooth profile.

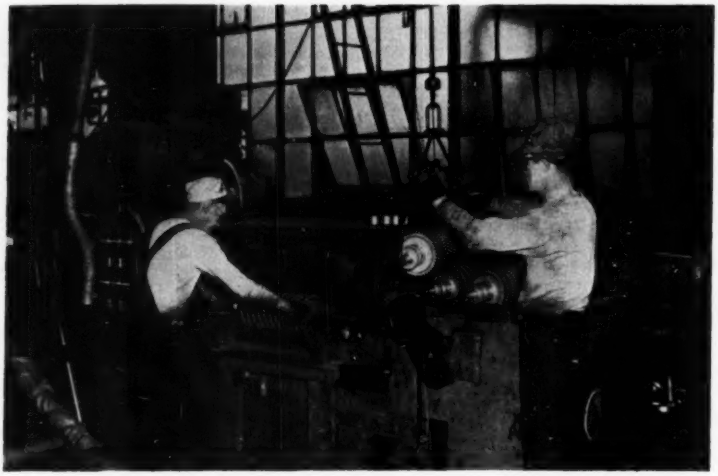


FIG. 5 MACHINE FOR SHOTPEENING GEARS IN PRODUCTION

In some cases these craters grow larger and more numerous until finally sufficient material is removed so that complete failure results. In other cases it may develop as very small pits which progress to a moderate degree and then stop without any real damage.

Wickendon, Brophy, and Miller (7) have been successful in establishing some quantitative data, and in determining the life of gears at which pitting begins. These tests were run on a special test machine designed to minimize variables in testing. It is to be hoped that such tests will add appreciably to the information now available on pitting. It is rather generally accepted that pitting is the result of high compressive stress, but, to the author's knowledge, there are not sufficient data available to establish the validity of any method of calculation on the basis of actual fatigue tests. A value of maximum compressive stress can be obtained by the method described later in this discussion under Scoring Resistance. A limiting value of 200,000 psi has been used with some success. This is a qualitative value, but it is believed to be on the conservative side.

SCORING RESISTANCE

Scoring is caused by a combination of high compressive stress and high sliding velocity on the contacting tooth surfaces. By means of an approach similar to that just described in appraising the bending-strength formula, a method of calculation of scoring resistance in spur and helical gears was developed by the author, under the direction of J. O. Almen, at the Research Laboratories Division, General Motors Corporation. Dynamometer test data were accumulated on a very large number of gears, along with the complete design information. With these data at hand, various assumptions were made until good correlation was obtained between calculated values of scoring resistance and the actual test data.

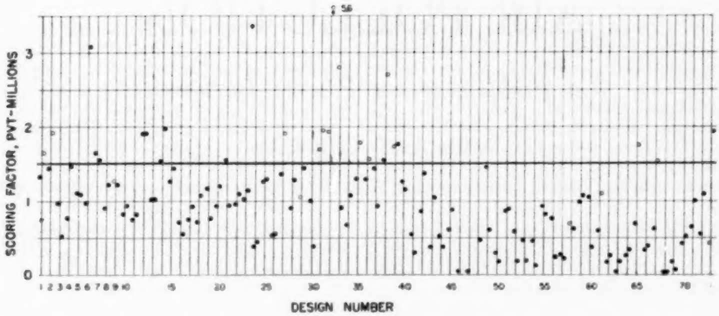
Briefly, the method selected (6) is based on the same assumption, with regard to distribution of the transmitted load, as that used in the bending-strength calculation discussed in the foregoing. The method consists of the calculation of the product *PVT*.

Term *P* is the maximum compressive stress as determined by the Hertz equation for cylindrical surfaces, for a point located at the tip of the gear tooth or pinion tooth, and based upon the total tooth load derived from torque, the average total length of lines of contact, and the curvatures of the tooth surfaces in the plane normal to the line of contact at the selected point. *V* is the sliding velocity of the surfaces at the selected point. *T* is the distance in the plane of rotation from the pitch point to the selected point.

The degree of correlation of the calculated values with actual test results can be seen from the chart in Fig. 6 (reference 6).

The data shown in this chart represent actual test results on well over 50,000 pairs of aircraft gears. The gears tested covered a wide range of requirements. The torque requirements varied from a few foot-pounds up to several thousand foot-pounds, and the speed requirements ranged from a few hundred rpm up to 28,000 rpm. All of the test data accumulated were on fully hardened spur gears, lubricated with mineral oil. External as well as internal gears are included.

Note that, by and large, those gears which have a calculated *PVT* factor in excess of 1,500,000 failed by scoring, whereas those with a *PVT* factor of less than 1,500,000 had no scoring failure. There are a few exceptions, but not without reason. For example, point No. 6 represents a gear in a high-ratio pair in which, with a true involute profile, tooth action would have taken place very close to the base circle, resulting in a high compressive stress, along with high sliding velocity. The calculated *PVT* factor would indicate scoring failure. However, in this case, the gears were made with a pronounced profile modification at the tip of the gear teeth, thus decreasing the actual compressive stress in that region. It should be mentioned, however, that this particular design was studied and it was found that a *PVT* factor of less than 1,500,000 could have been obtained by decreasing the gear addendum and correspondingly increasing the pinion addendum, without tooth-profile modification. The two points which show scoring failure at a low *PVT* value were in planetary units with a large number of planetary pinions. In both cases, the load was assumed to be distributed equally among the pinions which



O, Teeth scored; ●, no scoring

FIG. 6 CORRELATION OF SCORING FACTOR, *PVT*, WITH ACTUAL TESTS ON 73 GEAR DESIGNS
(Pinion tip, left of line; gear tip, right of line; safe limit = 1,500,000 *PVT*.)

is probably erroneous. Assuming fewer pinions carrying the load, the *PVT* factor would exceed the safe limit of 1,500,000.

It should be mentioned that with extreme-pressure lubricants, a value of *PVT* in excess of 1,500,000 may be used.

BALANCED DESIGN WITH SHOTPEENING

A study of the design considerations from the standpoint of both bending strength and scoring resistance reveals that there is some conflict between high bending strength on the one hand and high scoring resistance on the other. For example, according to the formulas, a coarse pitch is desirable for bending strength because of the greater thickness at the root of the tooth. However, in some cases this would be impractical because a coarse pitch would necessitate long teeth for continuous action. This, of course, would mean an increase in the length of action and consequently, higher sliding velocity. Furthermore, with long teeth, particularly in high-ratio gears, tooth action approaches the base circle of the pinion which in turn results in a high compressive stress because of the small radius of curvature of the pinion tooth in that region. In such a case, an increase in bending strength may lead to scoring tendencies.

Therefore, in order to obtain satisfactory operation with minimum weight, it may be necessary to compromise between bending strength and scoring resistance. This leads to a logical question as to the usefulness of shotpeening relative to scoring resistance. For a given design, experience indicates that shotpeening has little direct influence on the scoring tendency of gears of the same design and operating conditions. However, since a balanced design may involve a compromise between bending strength and scoring resistance, a distinct advantage can be taken by designing the gears with a finer pitch in favor of scoring resistance. This would result in decreased bending strength which can be restored by shotpeening. By this reasoning it can be seen that shotpeening can be used directly for increasing bending fatigue strength, or indirectly, by proper design consideration, for increasing scoring resistance.

CONCLUSION

It is common experience that certain design factors can be used to improve bending strength. It is also generally accepted that bending strength can be increased materially by shotpeening. However, the possibilities of shotpeening, in combination with appropriate design, as a means of increasing scoring resistance probably has not been appreciated. The intention in the foregoing discussion is to point out some of the advantages of shotpeening in combination with the design of gears as a means of (*a*) reducing bending failures, (*b*) reducing scoring failures, (*c*) reducing weight or space requirements, (*d*) reducing production costs.

With respect to reducing production costs, the extent of such reduction would vary considerably for various applications, but it might be of interest to cite an example of what can be accomplished. An estimate of possible reduction was made on the basis of a production machine used for shotpeening large coil springs. Assuming an increase of 10 per cent in allowable stress, the saving in material only, by virtue of decreased size, was estimated at $25 per hr of machine operation after all peening costs were taken into account. The estimate was very conservative in every respect.

ACKNOWLEDGMENTS

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AIR POLLUTION

A Problem of the Process Industries

By A. G. CHRISTIE

PROFESSOR EMERITUS, THE JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD. PAST-PRESIDENT AND HONORARY MEMBER ASME

THE American public is becoming more conscious of air pollution as evidenced by increasing publicity and more restrictive local ordinances. The contamination of the atmosphere is due to many causes, not all of which are understood by the public. There is no pure air in nature. It contains wind-borne dusts, pollens, odors, and gases from natural sources. The following are man-made contributions to air pollution: automobile and truck exhaust gases; winds carrying dust; trash fires; smokes from chimneys of industrial and home units; and fumes, odors, and dust discharges from factories. Regardless of the relative proportion of these contributions that is made by the process industries, it is the duty of those in responsible charge of such plants to take every reasonable measure to abate the discharge of these objectionable products into the atmosphere. If this is not done voluntarily, it will be forced by more restrictive legislation.

Much has been written about the economic losses that result from the presence of smoke, tarry products, and corrosive gases in the air. Laundry bills are increased under unusually severe conditions; public health may be menaced by increased colds and pulmonary diseases; vegetation may be destroyed and structural materials may suffer damage. These losses will receive no further consideration in this paper. The immediate question is, "What can the process industries do to lessen air pollution?"

Different elements may contribute to air pollution in different localities. In general, air pollution of an objectionable character is usually associated with certain local meteorological conditions such as lack of winds, temperature inversion, persistent fog, and the presence in a comparatively stagnant atmosphere of smokes, dusts, and gases.

Regarding air movements, many industrial communities are located in relatively narrow valleys or in basins bounded by high hills or mountains. Such localities are protected by the surrounding heights from prevailing winds caused by air movements over large sections of the country. Local drafts up and down the valleys tend to retain contaminated air within the district. There is a lack of winds to disperse this air over the surrounding hills. Terrain, as a factor in air pollution, requires further study.

This situation is further aggravated by fogs which tend to accumulate and remain in valleys. The minute water droplets which constitute the fog act as nuclei to collect dust, smoke, and acid gases. These then obscure the atmosphere, decrease visibility, and reduce the sunlight that should reach the earth. When there are not extensive wind movements, fogs tend to remain stationary over these areas and increase in density and in offensiveness with time due to continued absorption of the objectionable contaminants.

Temperature inversion is a condition not so well understood but it prevails for some periods over certain localities. In a normal atmosphere, the temperature decreases with elevation above the earth's surface. The term, temperature inversion, is given to a condition where strata of air warmer than that at the earth's surface prevail at a moderate elevation over a considerable area. The lower atmosphere near the earth's surface is colder than the strata above, and being of greater density, remains close to earth. The presence of the stationary upper warm strata of air limits vertical air movements from the earth's surface. In other words, the upper strata act like a warm blanket tending to retain the lower atmosphere in a stationary condition. As a consequence, the pollution of the lower atmosphere steadily increases and may reach such proportions as to be harmful to people.

These meteorological conditions seldom occur separately but are generally combined. Thus at the time of the Donora, Pa., disaster, fog, lack of wind movement, and temperature inversion prevailed for some days. The troublesome "smog" of Los Angeles, Calif., occurs when salt fog, little or no wind, and temperature inversion are present in this section of California. Unfortunately, little can be done to correct these meteorological conditions. Care should be exercised in choosing sites for new process plants to avoid localities subject to air stagnation and temperature inversion. Engineers must concentrate their efforts on means that will lessen the amount of impurities discharged into the lower atmosphere and thus reduce its pollution, particularly in areas subject to temperature inversion.

Impurities discharged from process industries have included smokes from fuel-burning furnaces; dusts from such processes as cement, lime, mineral wool, iron and steel production, rock crushers, and others; gases from chemical plants, paint factories, smelting plants, and the like; and odors from packing plants, chocolate factories, bakeries, and similar sources.

The majority of process plants have some type of fuel-burning equipment. Any smoke or fly ash from chimneys of these plants are visible contributors to air pollution. These can be easily detected by the public, and consequently these factors received early attention in smoke ordinances and by smoke inspectors. Available coal is increasing in ash content so that fly-ash discharges will increase if preventive measures are not taken. Many industrial centers have ordinances controlling the discharge of smoke and fly ash. The central stations of public utilities have large chimneys through which the flue gases from large quantities of coal are discharged. Though the amount of smoke and dust per cubic foot of these gases may be small, the large mass issuing from the chimney top causes a diffusion of light and a dark appearance. The public required that such chimney discharges be minimized. The electrical utilities have been and are conscious of public opinion and are generally interested in civic betterment. They have led in the installation of smoke-prevention equipment and dust catchers. No new central station is designed now without such devices. A considerable part of the decrease of visible smoke from such plants is due to improvements in fuel-burning equipment and furnace construction. The use of washed coal has been advocated as a means for reducing air pollution as its ash content is lessened by washing.

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General practice in central stations is to install cyclone separators to catch the fly ash from boilers with underfeed or traveling-grate stokers. Mechanical or electrostatic separators are used in spreader-stoker or pulverized-coal-fired stations. The fine dust that adheres to the grounded elements of the electrostatic precipitator is often caught up by the flue gases on rapping and the resultant instantaneous chimney discharge may exceed allowable dust limits. This emission looks bad and often leads to public complaints. It may be lessened by continuous vibration of the grounded elements and by low gas velocities through the electrostatic precipitator. But there is seldom room for such a large electrostatic installation in the width of a boiler space. In some plants double-deck electrostatic units have been proposed to get low velocities. Another plan is to place the cyclone or other device beyond the electrostatic to catch a large portion of the residual dust from rapping.

It has been suggested that washing the flue gases would remove the smoke, fly ash, and objectionable gases. This has been tried in a number of cases and has given rise to other problems. The wash water of such a process becomes acid, attacks any steel with which it comes in contact, and cannot be discharged into the river or bay. Neutralization by alkalies proves expensive. To wash gases thoroughly and dispose of resultant wastes from water treatment would cost about $2 per ton of coal burned based on British experiences. This would increase the cost of electric service by the utilities. There is another difficulty with gas washing. In winter months the cold water cools the gases to such a low temperature that the gases leaving the stack fail to rise. If temperature inversion also prevails, these gases fall to ground level and due to their high humidity and high carbon-dioxide content soon constitute a nuisance to the neighborhood as well as to the boiler plant itself.

Domestic chimneys discharge considerable amounts of smoke and gases when bituminous coal or oil is burned. Domestic incinerators deliver much smoke and ash. Smoke and dust catchers are too expensive to install in such plants. The remedy lies in the insistence on the use of low-volatile coal and on the installation of furnaces that do not smoke. Use of natural gas in homes has lessened the smoke nuisance in residential districts.

Many industrial plants have boilers with small, old, poorly designed, and often indifferently operated, hand-fired furnaces. The attitude of owners in the past has been that these old plants, which are often only used during the heating season, cannot be economically equipped with dust-catching devices. But such plants contribute to air pollution, and more rigid enforcement of smoke ordinances may force the owners of such plants to install preventive equipment. Before such equipment is purchased, the problem should be studied by an experienced engineer. In some cases, the installation of mechanical stokers with coal and ash-handling machinery may lessen smoke production and prove profitable in view of increasing labor shortages and high wages.

However, several factors need consideration before deciding to install new stokers under old boilers. Boilers that have been in service twenty-five years or more are in general of a less efficient design than those now available. Their fuel-burning equipment and furnace construction would be considered poor practice today. Their operation in general is inefficient according to present-day standards, particularly as they generally lack such heat-recovery equipment as economizers and air heaters. Smoke emission may be reduced and large fuel savings secured by the installation of modern boiler plant.

There is a tendency to retain old chimneys when replacing boiler plant. Sometimes these chimneys are suitable for the new plant but often they are too low or improperly designed to give adequate dispersion of gases after leaving the chimney. Dispersion is receiving much attention, and wide distribution of residual gases is desirable. This is best secured by using a high chimney. British practice requires a chimney at least $2^1/_2$ times the height of an adjoining building. Where induced-draft fans are used, American practice is to increase the gas velocity at the chimney top from the old value of 20 to 30 ft per sec to as high as 120 ft per sec at full chimney capacity. This increase in velocity adds little to fan power. Observation indicates that in a 10-mph wind, these higher velocities lift the smoke plume to a height in feet above the chimney top equal to the velocity in feet per second. For example, with 120-ft per sec velocity, the plume may be lifted 120 ft above the chimney top. This assures much wider dispersion of the gases. Chimneys have been built of such form that the gases are slowed down toward the top to recover the velocity head. Such chimneys must be of considerable height to obtain wide dispersion of gases.

When dust-catching equipment is to be installed, it pays to get the best available. There is a decided tendency throughout the country to pass ordinances with lower permissible dust contents in the flue gases than formerly allowed. Hence dust catchers that may just satisfy present requirements may fail to be adequate under later regulations. Replacement of these unsatisfactory catchers results in additional expenditures that could have been avoided by the original purchase of a superior device.

Chimney dusts in general have no economic value and the expense of dust catchers and their operation must be considered by the plant owner as the price that society demands of him for permission to operate his process plant.

Process dusts can in many instances be recovered by available equipment. Such dusts may have economic value such as, for instance, iron-ore dust from blast furnaces, cement-mill dusts, lead and zinc oxides, etc. Suitable equipment has not been developed to catch certain industrial dusts from very hot gases such as those from brass or iron cupolas and Bessemer and other converters. Much development work remains to be done to remove dusts from these and other process discharges. For instance, it is claimed that minute grains of elemental sulphur are discharged from certain industries in the Los Angeles area and these cause eye irritation. The presence of selenium particles in the air is even more objectionable because of its odor when reacting with moisture.

The health and safety of workers in process plants is increased by air-conditioning and ventilating the buildings. Dusts from ventilating systems are often carried into the atmosphere with the discharge air. Prevention of such dust discharges would lessen air pollution.

Gases, vapors, and odors from process plants contribute to air pollution. Certain odors are not in themselves offensive, yet even the persistent odor of a food-processing factory may become obnoxious if prevalent all of the time in a neighborhood.

Certain gases and vapors from process industries are objectionable because of their destructive action on vegetation or their corrosive character. Much has been done in the metallurgical industries to lessen the discharge of such gases. Chemical industries are frequently faced with the problem of gas or vapor emissions of an obnoxious nature. Other industries have similar problems. There is no method known at present in many cases by which these discharges may be recovered at any reasonable cost or which would yield a return on the operation.

In other cases, no economic use can be made of the re-

(*Continued on page 575*)

Are ENGINEERING GRADUATES *Prepared for* THEIR JOBS?

By D. S. KELLOGG

CHIEF ENGINEER, MAXSON ENGINEERING DIVISION, THE W. L. MAXSON CORPORATION, NEW YORK, N. Y.

INTRODUCTION

A group of engineers were gathered about a drawing board in complete silence, their brows knit. One was leaning on his elbows, his eyes half closed, a second was staring abstractedly out the window. Another had his right elbow in his left hand while he drummed a steady beat on his forehead with a pencil. The company porter was busy at his daily task of pushing a broom across the floor, but he was also watching the group with considerable interest. As he passed the chief engineer's desk he leaned over and said, "Mister Mac, what are those fellers doing over there?" The chief engineer looked up, smiled and said to him "Why Dudley, those fellows are thinking." Dudley continued sweeping for a few moments and then leaned over again. "At least," he whispered, "you hopes they is!"

Dudley's curiosity was aroused over whether or not anything was being accomplished. He evidently had some doubts which I am not prepared to prove or disprove. The story is true, however, and emphasizes one of the biggest problems that faces the men who manage any business or professional organization whether it be in the field of engineering, manufacturing, advertising, selling, merchandising, or anything you want to mention. This problem is the problem of accomplishment or of "getting things done." The man who can get things done is bound to succeed for the very reason that success and accomplishment are synonymous. What more important qualification could a young engineer have, in starting his professional career, than the ability to get things done?

Of course there is no substitute for sound theoretical and practical technical training during the college undergraduate and graduate learning periods. With the strides that have been made in technical progress, it is becoming more and more difficult to prepare for a future job in a given amount of time without almost knowing in advance what the job is to be. A greater burden is being placed on the educators responsible for selecting the material for the courses. In spite of their continued efforts, there are many dislocations during the first few years of employment. Therefore the thoughtful student will make the most of his generalized training, realizing full well that the first demand from his first employer might be far removed from his specialized field. In fact, his entire career might successfully be in some branch of engineering for which he has had very little formal preparation.

But aside from the problem of choosing the right technical subject matter for engineering courses, of which much has been said and written, there remains this vital problem of getting things done which faces all engineers and which has received apparently very little, if any, organized attention. The expression is often used rather glibly and without full understanding of its true significance. Let us therefore analyze the problem to determine what demands are placed upon the engineer by an efficiently functioning organization. First of all, he must find practical solutions to new, unsolved problems. Before even starting to solve them he must be able to organize his thinking. He must have a clearly established procedure for determining what has to be done, how it will be done, who will do it, and when it must be done. How much specific training is given to the undergraduate or graduate student in how to organize his thinking?

Assuming for the moment that his thinking has been organized and that he has arrived at a method of attack, he must now proceed with the doing of it. In doing something there are many personal characteristics that he should possess to accomplish the desired results. He must have careful work habits, he must use good judgment, he must think positively, he must adhere to a program. These are items of self-behavior concerned with doing. Then, there are relations with others, also concerned with doing. These "others" are human beings, each one of which is an enormously complicated machine operating from the same fundamental motivations but never quite the same in degree or outward manifestation. They must be communicated with orally and in writing, they must be directed or followed, their questions must be answered, they must co-operate and be co-operated with. How much specific training is given to the undergraduate or graduate student in how to work with himself and in how to work with others?

With these thoughts in mind, let me ask the primary question with which we are concerned here and which I think can be answered by any of us who have completed a formal engineering education: Are engineering graduates prepared for their jobs? I believe the answer will be a definite "no."

We will now examine in more detail what the student should be taught in order to help him (*a*) organize his thinking, (*b*) work with himself, and (*c*) work with others. We will consider how these things can be brought into the curriculum; a suggestion will be offered as to who might best do the job and when it should be done.

What SHOULD THE STUDENT BE TAUGHT TO HELP HIM GET THINGS DONE?

Organization of Thinking. There are just four words which must be answered carefully before starting to do a job; what, how, who, and when. If these are known completely, we are a long way toward our objective. It has been said with a good deal of truth that knowing what has to be done is 50 per cent of a job, how it is to be done is 40 per cent, and turning the crank, or doing it, is 10 per cent. Perhaps this is somewhat exaggerated, but it does point out the importance of getting well organized before the doing takes place.

There are almost unlimited daily situations which arise in which the "what" question remains only partly answered. Whenever a request or an order passes from one person to another the statement of what is required must be given. Many organizations have pads inscribed with expressions like "avoid verbal orders," or "write it" to emphasize this point.

Let us say, for example, that an engineer is asked to design an electric motor. In order for him to do the job, he must be given a clear picture of what is required; that is, it must be

specified completely. He will need to know what horsepower, what speed, what voltage supply, and many other similar items of information. One missing item can mean a lot of wasted time in producing something that will not do the job. It is his responsibility too, to make certain that he knows what is required before starting to carry out the design. If he has been told to make it as light as possible, you may think that is sufficient information. He might interpret this requirement in an extreme way by going to expensive construction where it wasn't warranted. He should ascertain exactly what is meant by "light as possible" if he is doing his job properly. There is an ever-present possibility for misconveyance and misinterpretation of information. It is a vital part of a good engineer's job to find out exactly what is wanted before beginning to carry out an assignment, or to define what is wanted if he is giving out an assignment. He must be trained to look for the what, and he must be made to realize the great ease with which it can become distorted.

After the "what" has been determined for a particular job, it is ready for a plan or program and for scheduling. This takes care of the "how," "who," and "when." Even though our engineer designing the motor has very carefully defined the "what," he can still make a very serious mistake if he starts to work without carrying out the remainder of his preliminary organization of the job. If he doesn't determine how the job is going to be done, he may start to work by designing the fan that is to cool the motor or he might start on the junction box. We know that many things just as ridiculous as this are being done every day by well-meaning individuals who haven't first figured out the "how." On a small or large assignment, the how can mean either success or failure.

Very often the how is tied up with the who—who is available to do the work, and the when—when must it be done. If the wrong approach is selected for the personnel who are going to do the work, they may not be capable of doing the job; or if the wrong personnel are assigned to the job, it may never be finished. The job might also be finished too late to meet the requirements because the right things were done at the wrong time, thereby missing the "when." Time is almost always a vital part of an engineering job.

We have been talking about the preparatory phases of getting things done—the importance of organized thinking and of determining the what, how, who, and when of a problem. The value of adequate preparation of the student engineer in learning how to organize his thinking cannot be overemphasized.

Let us now turn to the "doing" phase of getting things done.

Working With Yourself. Those of us who own automobiles are usually interested in getting the best possible performance out of them. We check gas and oil consumption, power on the hills, and general ability to stand up under adverse conditions. If something isn't working quite right, we take constructive action to fix it up. It is the function of the car to "get there," and we are not satisfied with less than the best performance. So it is with a business or professional career—in order to "get there" with successful accomplishment, we must check and analyze our individual traits and characteristics constantly to determine whether or not we are doing everything that is necessary, and what we aren't doing right. When we find something wrong, we must take corrective action and then continue to observe our performance.

There are many basic habits that should be cultivated in order to succeed in the business world. Some of these are purely personal in nature, that is, they do not involve other people. The desirability of getting the engineering student to understand and acquire these habits can readily be appreciated.

Probably the most important single item to learn is that we can always learn something new that will help us to do a better job. When a person is satisfied with his ways of working or when he reads an article, for example, about some human weakness and doesn't say to himself "this could be me—is it?," it is a danger signal; he is on the way out! You might say, "What's the use—life is too short—why be a perfectionist?" I am not advocating "perfectionism" because that is a highly inefficient state of mind wherein the good engineering compromise, or the real solution is discarded for some ideal that can never be reached and, therefore, results in never getting things done. I am advocating that it be drummed into the engineering student that life is earnest, that there is individual competition just as there is competition between companies, that the individual who is not awake to this competition is limiting his future just as the company that won't analyze and correct its operations is headed for the financial rocks.

What are some other desirable personal characteristics that we admire, perhaps without realizing it? Good judgment is one which you can think of right away. The ability to get the facts, weigh them impartially, and reach a decision is an important operation requiring good judgment. One of the horrible experiences of a supervisor which usually but not always exclusively occurs before he has been exposed to his job very long, is to get "some" but not all of the facts and then to make a decision. As the words of wisdom come from his mouth another fact will enter the picture and he finds it necessary to reverse his decision. This can go further—a sort of "seesawing" takes place as the additional facts are brought to light. He gets very confused and wonders why they never told him it would be like this.

Another good habit to acquire is the habit of thinking positively. That song "Accentuate the positive, eliminate the negative, look out for Mr. In-Between," was pretty good advice! If all the hours spent by the individuals in a company on how or why something cannot be done were spent on how something can be done, the results would be stupendous. Many people are just as happy proving something cannot be done as they are trying to do it; sometimes they are even happier.

The insidious negative approach invades all forms of thinking. Which one of the following statements was written by the man who will get the job done?

"Unfortunately, the repeated high torsional stresses on the shaft caused a fatigue failure which will further delay the program. The material selected for the application was not suitable nor was the heat-treatment controlled properly. Space limitations make it difficult to improve the cross section without going through a radical redesign which is not considered advisable. Another effort will be made along the previous line of approach, which it is hoped will be successful.

"A better material for the shaft, SAE 4340, with closely controlled heat-treatment was selected as a result of the shaft fatigue-failure investigation. A new schedule has been set up and is being followed to complete the unit in March. Sound theoretical reasoning supplemented by the test results, indicates this improved material can perform successfully without increasing the shaft size or disturbing the highly desirable compact arrangement of the present design."

The conclusion is obvious, the habit is not hard to acquire, and the student engineer is the fellow who should be acquiring it by proper training during his regular course of study.

The subject of desirable self-behavior in business could very well fill several volumes. I have mentioned a few aspects of personal conduct for purposes of illustration. It would be easy to continue and talk about such things as proper attitude, willingness to roll up the sleeves and go to work, desire to adhere to a program, and the realistic appreciation of the relation

between time and money. Rather than do this, it seems desirable to say a few words about working with other people.

Working With Others. Perhaps no phase of daily business activity has received less attention in the past than human relations, or the science of working with others. In recent years this fortunately is being increasingly realized. All the theories, books, techniques, facts, instruments, machinery, and facilities in the world aren't any good without the people to go with them; it's the human beings that get things done—human beings working together.

When an engineering graduate enters industry, he usually realizes that he must get along well with his associates and please his boss. From years of experience, he does pretty well at getting along with his associates on a social basis. He must now work well with them as part of a co-ordinated team which, for impelling competitive reasons, must function in a highly efficient manner or go hungry. If he succeeds in his first assignments, he will find himself given more responsibility and authority and will discover that he must get other people to do things. The way he talks to his associates, or his subordinates, or his supervisors becomes important for satisfactory results. Often this is not realized until after a lot of perplexing experiences in which people seem to "take things the wrong way" or don't do what they're asked to do. He must learn what makes people feel dissatisfied and what makes them contented; what makes them disinterested and what makes them want to get things done.

A young engineer once was passing through his company's machine shop and stopped for a moment to watch a milling-machine operator take a cut on a part that the engineer had spent considerable mental effort in specifying. The material was tough, and he was impressed with the glamor of the situation, the fact that he had selected the material for the very properties that were making it hard to machine and how well the selection had been made—there was proof—right before his eyes.

"It sure is slow cutting, isn't it?" he remarked in friendly fashion to the operator before going on about his business.

Ten minutes later the shop superintendent was standing in front of him in a highly aroused state. "From now on I want you to mind your own business and keep away from my shop and my men. I've got enough trouble without your telling one of them he isn't working fast enough to suit you."

It took a lot of explaining to fix it up and the engineer learned something important—that it is very easy to be misinterpreted in a way that will cause a lot of serious damage in human relations. The psychologists tell us that human beings have certain basic motivations which determine all of their actions. Some may be more in evidence than others or may show up in slightly different ways, but they are nevertheless present and must always be considered for successful human relations. Some of the more important basic motivations are the desire for security, the feeling of self-importance, curiosity, the desire to create, and the desire to play. The milling-machine operator who complained to the shop superintendent about the engineer's casual remark was being motivated by a desire for self-importance (someone thought he didn't know how to do his job), and his desire for security (he thought his job was being threatened by being considered slow). No wonder he was disturbed!

The graduate who is armed with a thorough understanding of human relations and their vital importance to success will have a major part of his future well insured.

Another invaluable asset is the ability to get up on one's feet and think and speak effectively to a group. We have all been to lectures where the person delivering the talk speaks in a low uninteresting monotone. It is usually hard to keep from falling asleep. By contrast, what a pleasure it is to hear someone who can get up and forcefully and effectively keep the subject alive. This ability is not something that is inborn. It can and must be acquired by training, concentration, and hard work. Some may say they do not care to be public speakers. They do not realize that the techniques of public speaking must be used to a large extent when they communicate with their associates during normal daily activities. In a business conference, the usual purpose is to evolve some new ideas or to reach some decisions. The man with the best idea might just as well not be present if he cannot put the idea across to the others. He must present it clearly, logically, and so that everyone can hear it or it withers and dies.

In working with other people, effective writing of letters, memoranda, and reports is equally as important as effective speaking. The U. S. Air Force made the term "gobble-degook" popular during the war. This was a good name for the opposite of plain talk. It is virtually a certainty that you could go through the files of any business organization in the world and cull out hundreds or thousands of examples of poorly written material. This is certainly a fertile field for improvement and a very logical subject for an undergraduate training program. The engineer who cannot put his thoughts, results, and conclusions down on paper in a usable manner without the need for editing, rewriting, and adding material is going to find his future limited unless he is in very unusual circumstances.

One more important ability should be mentioned under the general heading of "working with others." Anyone who has ever sat in on a conference, whether it is a large affair or an informal routine discussion between two people working on the same job, will testify to the amazing property they have of continuing almost indefinitely and of getting off on all kinds of tangents. Running a conference effectively is a tough job requiring concentrated effort, tenacity, and diplomacy. The purpose of the conference must stand out in great burning letters in the mind of the person who is conducting it. He will need every drop of perseverance if the conference is to produce a satisfactory answer to its purpose. People just seem to keep on wanting to talk about extraneous things. Of course, if everyone who is in the conference is capable of running it, the chances for extended diversions are reduced considerably and the job of running it is made a lot easier. For these reasons, the ability to organize and run a conference is surely a worth-while addition to the bag of tricks of our remodeled engineering graduate. Let us really give him the ammunition he needs to do his future job right.

We have been considering at some length "what" the student should be taught to help him get things done; now we will see "how" this can be carried out.

How CAN THE STUDENT BE TAUGHT?

I propose that a college or university, which is interested in preparing its students along the lines we have discussed, take the initiative of sponsoring a committee of responsible engineering executives of proved ability from representative industries. The function of the committee would be to review existing courses for adequacy and method of approach, to formulate new courses, which might be called "Industrial Training" courses, designed to prepare the student for his job and to write the necessary textbooks covering the material for these new courses. The courses should be given equal emphasis with others in the regular technical training curriculum. If necessary, room should be made by dropping less essential, supplementary courses designed to "round out" the student. An alternative plan could provide for summer sessions to cover the enlarged program. There is no doubt about the fact that indus-

try is demanding better-trained men. If the necessary courses cannot be fitted into the normal academic year, it must either be made longer or another term or two must be added to meet the requirements for the engineering degree.

With regard to existing technical courses, it can be said without much contradiction that the student is generally given exercises to work through instead of problems to solve. When he graduates into industry, he gets only the problems. Why not prepare him for them? It is this aspect of existing courses that should be given primary attention by the committee in making its review.

The Industrial Training courses must have certain features to make them successful. They must be crammed with specific practical examples drawn from industry, some of them perhaps adapted to daily campus life. Maintenance of a high degree of interest on the part of the student is essential. A few specific examples are worth thousands of words of abstract generalization. The courses must be reviewed periodically and revised where required to meet changing needs. The committee must, therefore, maintain itself active, rotate its chairmanship, and acquire new members. It is desirable, I believe, to have some steering by the faculty. However, this should be minimized until plans are fairly well formulated to avoid the danger of losing a valuable fresh approach. The student angle should also be obtained at some time during the formulation period.

Who SHOULD GIVE THE STUDENTS THE INDUSTRIAL TRAINING COURSES?

The answer to the question of who should give the Industrial Training courses comes rather readily. It seems clear that to derive the maximum advantage from the program, the courses should be presented by the various representatives from industry, who have helped in some way to formulate the courses. It should not be difficult to find fifteen or twenty engineers in responsible supervisory positions who would be willing to devote, say, a total of four hours of classroom time each per year on a rotating schedule established by the committee. The yield in better-trained engineering graduates would be well worth the effort.

When SHOULD THE INDUSTRIAL TRAINING COURSES BE GIVEN?

A comprehensive program of Industrial Training courses would seem to require at least 1 hour each week for a period of two years immediately prior to graduation. If there are thirty-two school weeks per year, this would mean that the material would be presented in 64 hours of lecturing and classroom work. If the time for an effective speaking course alone is considered, say, 20 hours, 64 hours seems hardly enough to cover all the ground. The final answer on time could come only after the committee had considered the details of the courses.

CONCLUSION

We have discussed an important aspect of business life that is vital to all who are in it. The necessity to get things done will remain as long as there is human life on this planet. The ones who succeed will always be the ones who can get things done. We owe it to our future engineers, who are now students, to prepare them adequately for the tasks that lie ahead of them—altruistically for their successful futures, and selfishly for our own progress and prosperity. Let us give them this training. Let us prevail upon the deans and faculties of our respective colleges and universities to initiate the necessary action and let us give them the real co-operation they will need in making the Industrial Training program successful.

Air Pollution

(Continued from page 571)

covered products and their ultimate disposal adds further problems. It is in the interest of all process industries that executives of concerns which are coping with problems of gaseous discharges should give full publicity to their experiences so that other managers may attack their problems of air pollution with more factual data.

The Los Angeles investigations showed that the catalytic effect of sunlight on certain gases, the combination of gases in the atmosphere, and the peculiarities of aerosols—those minute dust particles that seem to float indefinitely in the air—all require much further study to determine their properties and effects.

Many process industries use chemicals and solvents from which certain gases and vapors escape through chimneys or vents into the atmosphere. These may be caught in cooling, washing, or absorption processes and may possess commercial value. In other cases, their recovery may prove expensive yet necessary. It is not sufficient to wash these gases or vapors from the air only to form foul-smelling water courses in which fish cannot live.

It has been suggested that minute droplets of vaporized mineral oil are discharged into the air by petroleum refineries or condensed from vapors from oil stills and that these contribute to the eye irritation of the Los Angeles smog.

Noxious or offensive gases from process plants may not be readily removed from vents and much work remains to be done to stop such discharges. Odors from process plants may be offensive and constitute a nuisance. Some are difficult to prevent.

Managers of process industries must also consider whether their products contribute to air pollution in the hands of their customers. For instance, automobiles and trucks contribute largely to air pollution in our cities because of exhausts fouled by smoke, carbon monoxide, and other gases often caused by improper engine adjustment. Engine builders should study the problem of complete combustion under all operating conditions, or if this is impossible, of developing a catalyst to oxidize the carbon monoxide in the exhaust gases, on which problem some work has already been done.

Both ordinance administrators and plant operators are handicapped by the lack of simple standards to measure air pollutants. The Ringelmann chart used for smoke measurement has many faults and is little good on dust or gaseous discharges. Visibility alone is an uncertain standard. The ASME code on smoke measurement involves a lengthy test. Meters based on light intensity through a gas column have merit for smoke or dust measurement. At present there are no standards for gases and odors and no simple means of measuring their amounts. Much development of standards remains to be done.

The trend of public sentiment is that process industries must take steps to stop their contributions to air pollution. If this is not done voluntarily, legislation will force compliance with regulations or close offending process plants.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Industrial Vision Programs

A GOOD industrial vision program will pay a financial return to management on two counts—by increasing production and by reducing compensation payments for eye injuries, Dr. Leonard Greenburg, executive director of the division of industrial hygiene and safety standards of the New York State Department of Labor, said at the 1951 annual conference of the National Society for the Prevention of Blindness, in New York, N. Y. Dr. Greenburg cited several case histories to prove that a company's eye-care program will more than pay its way.

He explained that a complete industrial vision program should include two basic points: (1) protection against eye injuries, and (2) correction of substandard vision. Many members of management do not realize that these two points are interrelated.

For example, a few years ago a Midwestern manufacturing company discovered that employees with substandard vision were involved in twice as many accidents as were those workers whose vision was better than the minimum requirements for their job.

Actually, of course, we do not need that and other statistics to show that poor vision is related to eye accidents, he said. It seems axiomatic that a worker with poor sight is far more likely to stick a finger in the wrong part of a drill press than is a man with normal vision.

But statistics do help to show us how serious is the problem of substandard vision among industrial workers. It is estimated that 15 per cent of all workers in manufacturing plants have serious visual defects. Another 15 per cent have minor visual defects which must be corrected if they are to do their jobs safely and competently. When we examine the small industrial plants—where vision programs are the rare exception—the problem is even more serious, Dr. Greenburg declared. A survey in Baltimore, for example, indicated that 40 per cent of the workers in America's small plants have vision which is not what it ought to be for their jobs.

In addition to being accident prone, these men are also inefficient workers from the production point of view. As a case in point, a Midwestern printing plant found that workers with good vision were producing an average of $1384 a year more than employees with poor vision. By improving a worker's sight, the printing plant estimates that his production will increase from 50 to 90 per cent. Thus if he has been turning out five dollars' worth of goods an hour, his production will jump to as high as $9.50 an hour after his sight has been improved.

This increase in production, said Dr. Greenberg, will more than pay back the management of the printing plant for the cost of its vision program. But that's not the only financial dividend of a good vision program. It will also reduce the amount of eye injuries in a plant. And the 300,000 eye injuries which occur each year in American plants are costly—to labor as well as management.

The cost of an eye injury cannot be exactly calculated, he said. The pain to the injured worker is alone an immeasurable cost. But that is only the beginning, he warned. At least 1100 workers lose the sight of one or both eyes annually in accidents. In fact, some authorities estimate that as many as 5000 suffer some permanent visual loss. For many of these men, their injury means a lifelong reduction in pay—a reduction which is not nearly balanced by compensation payments.

However, if we consider only the cost of eye injuries in compensation payments, medical bills, and lost production, it is at least $250,000,000 a year for labor and management.

Dr. Greenburg pointed out that 90 per cent of our annual 300,000 industrial eye accidents can be prevented. Complete well-co-ordinated vision programs can accomplish this goal.

Modular Co-ordination

WHEREVER a new building is being constructed, a small mountain of waste material piles up beside it. To combat such extravagance, a system called modular co-ordination is described by William Demarest, Jr., in the April, 1951, issue of *Standardization*. Mr. Demarest is secretary of the Sectional Committee on Dimensional Co-ordination of Building Materials and Equipment, A62, in Washington, D. C. He is also

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

secretary for Modular Co-ordination of the American Institute of Architects.

Modular co-ordination, writes Mr. Demarest, is a system of dimensioning—a logical method for fitting standard-size building materials together without the need for "custom-tailoring" them on the site.

Its title, "modular," gives a clue to how it works. Following years of study by men representing practically the entire building industry, a module was agreed upon, to serve as a guide to the architect in setting the dimensions of each building he designed and to the manufacturer in fixing the sizes of his products—bricks, windows, and so on. Since a building is a three-dimensional proposition, the module is three-dimensional. It is a cube, one third of a foot high, one third wide, and one third deep.

Modular co-ordination works as follows: The architect designs his building in modules—the little modular cubes—as if he were putting together imaginary toy alphabet blocks. A third of a foot is four inches exactly, with no small fractions of an inch. The architect would no longer decide to make the front wall for a building, say, 24 ft, $7^7/_8$ in. wide. It would be so many modules wide. It would also be a certain number of modules high, and perhaps 2, 3, or 4 modules thick, depending on the construction. A window-opening in it might be, say, 12 modules wide and 16 modules high.

Thus the architect designs by arranging modular cubes. At the same time, the manufacturer standardizes the size of his products by the same modular cubes. As a simple example, one size of modular brick that is manufactured today is just right to occupy two of these imaginary cubes, side by side: 8 in. $\times$ 4 in. $\times$ 4 in. A window will be just the width and height to occupy so many modules; and so on, with doors, bathtubs, and all the other parts that make up a building.

The contractor's job becomes a great deal simpler, says Mr. Demarest. Comparatively speaking, everything drops into place. The front wall of the building just mentioned, for example, might be something like this starting from one side and working toward the opposite end: So many modules of brick and then a window-opening a certain number of modules wide. Again, so many more modules of brick and then perhaps an opening for the front door in the center. Each brick is just two modules long, so it is easy for the bricklayer to start and also stop the brickwork exactly where the architect intended. The bricks will not have to be squeezed together and he will not have to saw an inch or two off the bricks at the end. A window the same number of modules wide as the window-opening will have been ordered and delivered to the job. It only has to be placed in the opening and it will fit snugly, because it was made to fit an opening just that width. Again, the door will come just the right amount of modules wide and will fit into the brick wall easily.

In the case of these modular bricks just used, for example, if each takes up two modules, what has become of the mortar joint? The brick occupies two modular cubes, but it does not fill them. Suppose the mortar joint is half an inch. The actual dimensions of this-size modular brick as manufactured today are $7^1/_2 \times 3^1/_2 \times 3^1/_2$ in. Each unit, when the joint is included, fills the module. (And to fit snugly into the brick wall, the modular window has an extra $^1/_2$ in. width.)

This was all studied out before the manufacturers went into the production of modular sizes. In every case, the size of the joint has already been taken into account.

This method is more than just a good idea, Mr. Demarest states. It is already being used by many architects, all over the country. At Idlewild Airport in New York, the new airplane hangars that have been going up are modular. The University of Illinois recently completed a group of 30 modular houses for families of faculty members. In Houston, the enormous National Biscuit bakery is a modular building. There are office buildings, hospitals, and also schools in many states which are modular, as are more and more of the new structures that have been put up since the war.

Standardization

Value of Standards

STANDARDS underlie all mass-production methods and they facilitate the integrating processes necessary to large-scale production and distribution, it was stated by J. G. Vincent, a Fellow of ASME, and executive vice-president and director of the Packard Motor Car Company, Detroit, Mich., before a Management Session of the 1950 ASME Annual Meeting.

Standardization, when properly carried out, he said, results in the following advantages: (1) Lower inventory, with fewer sizes and more interchangeability; (2) lower purchase prices resulting from quantity buying on fewer sizes; (3) better workmanship resulting from building "more of the same thing"; (4) easier inspection; and (5) simplification of service and maintenance.

The first two advantages—lower inventory and lower purchase price—are typical. They are the customary advantages of standardization. They operate in almost every field of standardization, from manufacture of safety pins and window sash and electrical appliances to 13,000-ton presses.

Standardization benefits the manufacturer as well as the joint user. The manufacturer reduces the number of types he makes, and that starts a whole cycle of cause-and-effect developments. In his own shop it may accomplish some or all of the following: Fewer raw materials; smaller parts inventory; less special machinery; less obsolescence in material and equipment; reduction of idle man-hours by building up stock parts; less labor for each article produced. Standardization can mean shorter set-up time, faster processing, fewer change-overs, and longer runs. It can mean larger production units; smoother production flow; and simplified storage, distribution, and marketing problems. Inspection requirements can be simplified through quality control.

The consumer, of course, benefits from greater availability of goods, more convenience in use, prompter repair or exchange service, better quality, and, most of all, lower prices, Mr. Vincent said.

He pointed out that there is a great deal more standardization ahead of us than behind us. It is a modern science that we have only begun to explore.

For example, this country still has no standard table of cylindrical fits in airplane-engine parts. There is no standardization within private industry, none in government, and no reconciliation between government and industry—and nothing is being done about it.

Standardization in the drafting room would save much time and labor. Drafting-room practices are not only different between countries, but within the borders of this country as well, he pointed out. Blueprints are drawn and read differently in different parts of the country. There are differences between government practices and private-industry practice. There is a general under-use of timesaving graphical symbols. There is, in other words, a real need for standardization of drafting-room practices and symbols.

In describing the work of the American Standards Association, Mr. Vincent pointed out that there are now more than 1100 new and revised American Standards and they are being approved at the rate of one every working day. These range

from standards for kitchen measuring utensils to standards for tool shanks and tool posts for lathes, planers, shapers, boring mills, and turret lathes. The ASME has been responsible for the initiation of a number of important American Standards and has taken active leadership in the development of many others.

According to Mr. Vincent, the Russians are perhaps a generation or two behind us industrially, but they have reputedly been building up capital investment much faster than we—at the rate of about 30 per cent of their national income annually compared to our 18 per cent. They have the wealth of unlimited manpower, much of it slave labor. And they do know the value of standardization, he said.

In 1946, the last year for which estimates are possible, the Russians had issued 7000 national standards, and had a corps of some 200 engineers and technicians turning out two more each day. That would be the largest national standardization body in the world.

Standards for Better Quality

At the same session, Howard Coonley, Mem. ASME, chairman of the executive committee of the American Standards Association, New York, N. Y., declared that American industry is making three billion dollars worth of faulty products a year.

He said the "magic of standards" would cut down the number of rejects and make for better quality at lower cost. The widespread adoption of standards would enable the manufacturer to keep track of the effectiveness of his production process by means of a simple quality-control chart. The chart would indicate whether things were running smoothly or whether the manufacturer should be alerted for trouble in the production process.

Mr. Coonley said the development of quality control in industry generally had been a matter of "trial and error, application and misapplication" until 1941 when the first national standards were published. This made available in one source, data that had been developed over the years. However, he declared, there is a need for much greater standardization and widespread use of standards in modern techniques of quality control.

In using a simple quality-control chart, Mr. Coonley said, "control limits" are computed periodically from quality measurements made on samples of the product at regular intervals of time, for instance, one sample of five units every hour.

A unit may be a rivet, a shell fuse, or a test piece taken from a textile fabric, he said. These control limits are placed on the chart and the manufacturer keeps on taking samples at regular intervals. Each unit of the sample is inspected and a point representing the quality of the sample as a whole is plotted on the control chart.

As long as the plotted points stay inside the control limits, the manufacturer may reasonably assume that there is nothing in the process that will spoil the quality of the product. However, if a plotted point falls outside the control limits, this is a warning signal for the manufacturer to watch for trouble.

Mr. Coonley said standards also made for more effective managerial control. Standards help to relieve the pressure on executives up and down the line, from foreman to president.

This is accomplished chiefly by cutting down the number of decisions that have to be made through the reduction of innumerable problems of operating routine, he said. Every standard cuts down the number of conferences on the number of misfires, on controversies in the operation of the plant, and on controversies with customers. In most cases this is brought about by solving the problems in advance so that they never come before the executive for his consideration.

Mr. Coonley appealed to industry to be on the alert to keep the development of standards on a voluntary basis.

We cannot assume that the standardization movement in this country will remain within the free-enterprise system unless every responsible executive makes it his business to know what is being done about standardization on the national and international level, he warned. If you are not taking an active part in standardization activities within your industry or in the work of groups of industries, at least watch the trends. And when you are asked to throw your weight behind the united effort on the part of business to see that standards remain voluntary, don't hesitate to give your full co-operation.

Atomic Standard of Length

THE availability to science and industry of an ultimate standard of length has been announced by the National Bureau of Standards and the Atomic Energy Commission. The standards consist of spectroscopic lamps containing a single pure isotope of mercury. These lamps enable any research organization which has the auxiliary optical equipment to have for the first time an ultimate primary standard of length in its own laboratories.

Distribution of the lamps will be handled by the National Bureau of Standards. They will be available to qualified government, industrial, and educational laboratories both in this country and abroad, engaged in precision length measurements and related research. All requests for information and applications should be addressed to the Coordinator of Atomic Energy Commission Projects at the National Bureau of Standards, Washington 25, D. C.

The NBS-Meggers Mercury 198 lamps, prepared under the direction of Dr. W. F. Meggers, chief of the Bureau's Spectroscopy Laboratory, contain about one milligram of mercury of atomic weight 198. Mercury 198 is obtained by the transmutation of gold in a nuclear chain-reacting pile.

Mercury 198 is sealed in a small glass tube and caused to glow brightly by the application of high-frequency radio waves.

FIG. 1 DR. W. F. MEGGERS POSITIONS EYEPIECE OF THE TYPICAL TRAIN PRIOR TO OBSERVATION OF THE CIRCULAR INTERFERENCE FRINGES OF GREEN LIGHT FROM THE ELECTRODELESS HG 198 LAMP IN LEFT FOREGROUND

[Length measurements based on this interference pattern (background) can be made with an accuracy of one part in 100 million.]

The light waves emitted by the single isotope have extremely sharply defined wave lengths which can be used for length measurements of great precision. These particular waves are uniquely characteristic of the mercury and remain unaltered with time.

The new standard of length is based upon the wave length of the green light emitted by the lamp. This wave length, near 21 millionths of an inch, is consistently emitted with a reproducibility greater than one part in a billion. Length measurements based upon it can readily be made with an accuracy of one part in 100 million. New apparatus now under construction at NBS is expected to extend the accuracy to one part in a billion.

The measurement of length in terms of a characteristic radiation from a particular atom involves the optical technique of interferometry whereby the separation of two precisely flat plates is measured in terms of the number of wave lengths of light contained in the distance between them. Because the number of waves contained in any practical distance is determinable without error and because the wave length of the light from a single pure isotope of even atomic weight is so sharply defined, accuracies of measurement heretofore impossible can be obtained.

Although the world's official primary standard of length is still the distance between two lines on a metal bar, practically all precise measurements of length in the 20th century have been made and will continue to be made with light waves. When accuracy greater than the part in 10 million possible with the standard meter is necessary, only the new spectroscopic standard meets the need.

Up to the present time the wave length of the red light from cadmium has been used as a wave-length standard. In 1927 the International Conference of Weights and Measures provisionally adopted the value 1,553,163.13 wave lengths of cadmium red radiation as equal to 1 meter. In 1948 the NBS proposed that the meter be defined in terms of the radiation from mercury 198. This is now under consideration. Present measurements show that 1,831,249.21 wave lengths of the green radiation from mercury 198 equals 1 meter.

The fundamental advantage of mercury over cadmium is that the wave lengths of the light from mercury are much more sharply defined. Cadmium consists of six principal isotopes which are not separated. They emit light of slightly different wave lengths. When length measurements are made with light having this mixture of wave lengths, a region of confusion results which limits the accuracy. Mercury has other advantages: (1) The atoms are heavier, move about more slowly, and hence disturb the wave length less; and (2) the light can be obtained without heating the mercury to a high temperature and thereby speeding up the atomic motion. The life of the NBS-Meggers Mercury 198 lamps appears to be infinite; a lamp under continuous excitation since October, 1949—over 10,000 hr—has shown no significant deterioration. When all the advantages are considered, it is found that the Mercury 198 provides a standard 300 per cent more accurate than cadmium.

Recently the Oak Ridge Laboratories of the Atomic Energy Commission have succeeded in isolating practical quantities of Mercury 202 by magnetic-separation methods. The advantages of this isotope over the 198 isotope are negligible except for certain important problems in atomic research. Mercury 202 lamps, if needed for research in atomic physics, can also be obtained from the National Bureau of Standards by special arrangement. The wave length of the light from the 202 isotope has not as yet been accurately measured and hence the information needed for its use as an atomic length standard is not available.

Production Engineering

Automatic-Screw-Machine Production

Maximum production from single-spindle automatic screw machines depends on performing as many operations as possible at the same time, as well as using the highest speeds and feeds compatible with tolerance and finish requirements and tool economy. The productivity of the machine can be increased and subsequent operations reduced by the use of attachments. Careful consideration of these factors will do much in obtaining the highest possible efficiency in the use of these machines.

The various factors affecting production in automatic screw machines of the single-spindle type were discussed by W. E. Rollins of the Browne and Sharpe Manufacturing Company, Providence, R. I., during a Production Engineering Division Technical Session at the 1950 ASME Annual Meeting.

The modern screw machine with its attachments can be used to perform almost all of those machining operations where the stock or the tool is rotated. Special hobbing attachments have even been designed to produce specially shaped teeth or grooves on parts from bar stock. With a variety of attachments being available, consideration must be given not only to obtaining the highest possible production but also to performing as many operations as possible from the bar in order to minimize subsequent handlings.

The following five basic considerations in planning a job were discussed by Mr. Rollins: (1) speeds, (2) feeds, (3) choice of tools, (4) overlapping of primary operations, and (5) use of attachments.

Small-Lot Production

In another paper, also presented at the same session, M. S Curtis of The Warner & Swasey Company, Cleveland, Ohio, discussed the application of automatics to small-lot production. He referred particularly to automatic turning machines comparing them with hand turning machines.

Mr. Curtis assumes that if a piece can be made as accurately on an automatic as on a hand machine, the cost of manufacture is the deciding and really the only factor. If Q pieces can be made on an automatic for the same price as they can be made on a hand machine, then Q pieces is the "break-even" lot size. Any lot over Q pieces should therefore be made on an automatic, he said, and any lot of less than Q pieces on a hand machine.

The principal items entering into costs are: factory overhead, depreciation based on the cost of the machine and tools, cost of setup, and cost of production. A formula to determine Q, the break-even lot size using these cost factors, has therefore been worked out.

The formula indicates that anything that can be done to reduce the set-up hours required on the automatic, and to reduce the automatic depreciation rate which in turn means a reduction in cost of the machine and tooling, will reduce Q, the number of pieces in a lot for which an automatic can be economically tooled up.

Toward this end single-spindle and automatic chucking machines are being designed at the author's company, with the object in view to reduce set-up time and depreciation, and thereby broaden the field for automatic machines.

We endeavored to do the following, said Mr. Curtis:

Maintain flexibility without cam change; make the machine so that the toolholders can be mounted and adjusted to permit a large variety of work to be done with standard tooling; and make the machine rigid and accurate so that costly special

tooling measures would not be required to overcome deficiencies in the machine itself.

The important thing to remember, Mr. Curtis emphasized, is—that to economically use automatic machinery for small-lot production, it is necessary to reduce the setting-up time and the depreciation, or cost of tooling.

Machine-Tool Oil Cooler

AN oil cooler which dissipates heat generated in machine tools, and produces desired temperature through refrigeration has been developed by B. S. Williams Company, Inc., of Mt. Vernon, N. Y. This new device, called the Will-Cool Oil Cooler, can cool and control cutting oil to a predetermined temperature the year round.

Mr. Williams, president of the company, pointed out that since the maximum production capacity and accuracy of a machine tool many times requires the cooling and control of lubricating oil or hydraulic oil, this new oil cooler can be supplied to control also these additional oils to the desired temperatures at the same time. The lubricating and hydraulic oil are not exposed to the atmosphere while being cooled, he added.

Refrigeration right now is being used more than ever for removing heat from machine tools. But it is mostly being used to remove heat only from machine tools that are in trouble because cutting-oil temperature continually increases and causes tool wear or failure to hold tolerances. When cooling equipment is applied to such machines these troubles are removed. But usually only the normal production continues.

Refrigerant machinery, however, if supplied in the proper size, such as is the case with the Will-Cool Oil Cooler, can remove heat and control temperature up to the full capacity of the prime movers allowed by a machine-tool manufacturer. Or the time cycle can be increased within the possibility of adjustment.

The manufacturer claims that the use of this oil cooler makes possible the following advantages: increased capacity, uniform workpieces, uniform oil viscosity, longer tool life, less tool grinding, less adjusting time on machines, cooler workpieces to handle and gage, and reduction of oil evaporation.

According to Mr. Williams, increased production has been noted on the following types of machinery: Automatic screw machines, thread-grinding machinery, surface and cylindrical-grinding machinery, honing machinery, and all types of deep-hole drillers (over 2 in. thick).

The oil cooler, see Fig. 3, operates as follows: Oil from the sump (2) is continuously pumped through oil line (3) to top trough of the oil cooler (4) and flows by gravity down over the Multi-V Finned Tubes and back to machine-tool oil sump (2) through oil line (7).

Whenever the oil in machine-tool oil sump (2) increases in temperature, the thermostat (5) starts the cooling system. When the oil is reduced in temperature to a point satisfying the thermostat, it shuts off the cooling system.

A uniform head of oil is established over the entire cooling surface in the top trough by a metering device which controls the quantity of oil flowing over each tube. This metering device is so designed that the area automatically available to pass heavy viscous oil doubles, compared to the area for lighter, viscosity oil. It adjusts the flow of medium oils by a change in head of the oil. Each metering device is removable for cleaning and adjustable for unusual conditions, on the job.

This device also directs the oil against the primary (tube) and on both sides of the secondary (fin) cooling surface causing a larger quantity of oil to flow over the coldest surface and a thin film to flow over the surface which is not so cold. The distribution is always divided between inside and outside of secondary (fin) surface around the tube, whether the oil is light or heavy.

The velocity of the oil over the cooling surface, which insures continuous uniform cooling, is controlled by gravity. The only pumping energy expended is that required of a small pump to lift the oil from the machine sump to the top distributing trough. Gravity does the rest.

If the pump applied should deliver a large quantity of oil due to change of adjustment or the ability of the pump to handle a large quantity of, say, soluble oil and water, a special inside overflow is provided so the excess oil will pass inside the casing to the bottom trough and back into the machine sump, and only the correct quantity will pass over the cooling surface.

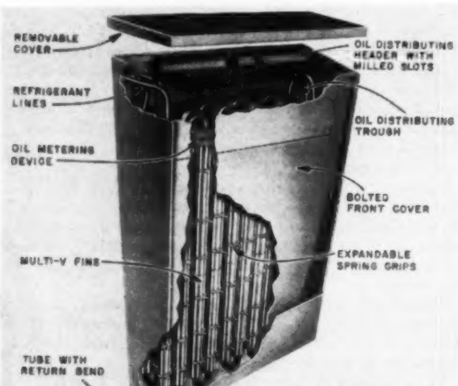

FIG. 2 WILL-COOL MACHINE-TOOL OIL COOLER WITH PART OF JACKET REMOVED

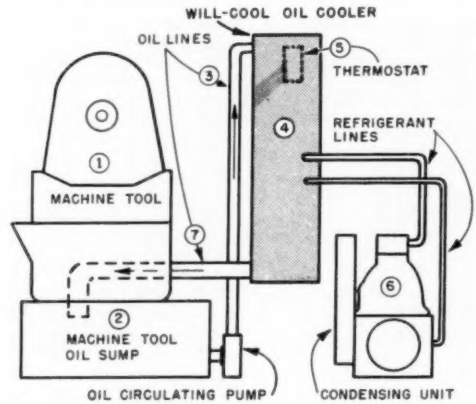

FIG. 3 SCHEMATIC APPLICATION OF OIL COOLER FOR COOLING CUTTING OIL WITH SEPARATE PUMPING SYSTEM WHICH CONTINUOUSLY FLOWS CUTTING OIL FROM THE SUMP OVER THE COOLING SURFACE

The distribution of Freon 12 is of the multiple-pass design to insure a minimum of pressure drop and temperature change found in a series-fed arrangement. At the bottom of the coil, provision has been made to insure the lifting of liquid and refrigerant oil.

The expansion valve has been developed to prevent overload when the system is started with overheated oil from the machine tool, and it will prevent the refrigerant from flowing to the coil during shutdown periods.

Before assembly, the inside surface of the steel tubes is thoroughly cleaned and inspected for smoothness and brightness. This insures a minimum of friction and maximum transfer of heat.

A secondary fin surface contacts the primary tube in a series of "V" shapes, each of which is a continuous part of a circular fin surface. The secondary or fin surface is extensive compared to the tube or primary surface, and is continuous around the tube. This secondary or fin surface is removable and replaceable. Expansion and contraction will not affect the pressure contact of the fin against the tube because the fins are held against the tube by a heavy, self-adjustable, removable, pressure-grip spring.

The vertical passes are open straight through the inside of the fin. Inspection is made by simply lifting off the cover of the top trough. If cleaning is necessary a rod or small brush can be pushed through or they can be flushed out with a cleaning fluid.

The new cooler will cool all machine-tool oils within their range of viscosities so that different oils may be selected if desired without affecting the operation of the cooler. The size range is from $1^1/_2$ to $7^1/_2$ tons. A simple method of calculating refrigerant capacity required for machine tools has been developed so that the Will-Cool Oil Cooler size will be large enough to control the temperatures in midsummer after the machine has been increased to maximum capacity.

Radar Jamming Tube

A WAR-BORN electronic tube, once used to jam German radar units, now is being groomed to serve as a high-power transmitter for color television, it was recently disclosed at a meeting of the Institute of Radio Engineers in New York, N. Y.

Details of the tube—described as "the most powerful of its kind yet developed"—were revealed to the group in a series of papers by Dr. Max Garbuny, Glenn Sheppard, and Richard Hansen of the Westinghouse Research Laboratories, who are collaborating in converting the device to its new role.

Although emphasizing that the tube—called a reflex Resnatron—is still in the laboratory stage, the scientists declared that "it opens the road to more television stations, greater range, and better reception, particularly in the field of color television."

When color television channels are allotted, the scientists explained, most of them will come from the so-called ultrahigh-frequency region being reserved for them. This will require special transmitters capable of sending out continuous high-power signals at these frequencies.

The reflex Resnatron in laboratory trials already has delivered approximately 1500 watts of power, Mr. Sheppard declared. With modifications now under way, it may be possible to increase this output by as much as six or seven times.

Greater power will mean more complete coverage and greatly improved reception, he pointed out.

The Resnatron achieves its ultrahigh frequencies by oscillating electrons until they move back and forth hundreds of millions of times a second. Emitted from several heated filaments and traveling in "bunches" spaced slightly more than a billionth of a second apart, the electrons reach a part of the tube called a resonant cavity—a hollow, copper-walled space that oscillates at a particular high frequency when excited by electrons traveling at the same frequency.

The unique feature of the converted Resnatron is its "reflex" action. As the electrons speed from the heated filament, accelerated by 10,000 volts of electricity, they meet a "repeller" that turns them around and directs them back to the positive screen of the tube.

This increased length of travel enables the reflex Resnatron to transmit in band widths wide enough to carry all the information needed for good clear color-television detail. Further experiments may make possible even wider band widths, they added.

76-Mm Tank Gun

DELIVERY to the Army of 76-mm guns to arm the new 25-ton General Walker Bulldog light tanks was begun by American Type Founders, Inc., Elizabeth, N. J., recently.

At an inspection of the ATF gun plant here, Army officers hailed the weapon—the first large gun produced by a civilian manufacturer since World War II—as superb and far superior in every way to the Russians' 88-mm tank gun.

ATF's new gun is a 16-ft, semiautomatic weapon, gyroscopically controlled so it can stay on a target even if the tank travels at 40 mph over rough terrain. It can be trained through a 360-deg circle, blasting in all directions.

The Army, in its own arsenals, built the first two of these new 76-mm guns, experimentally and largely by hand methods, and the commercial production at ATF is based on these prototypes.

Manufacture is underway in an ATF building constructed during World War II for turning out 37, 57, and 75-mm guns.

The new 76-mm gun is two feet longer than the Army's old 90-mm gun, and has an unusually short recoil, of only nine inches. This rifle consists of the finished tube with muzzle brake, breech mechanism, and evacuator. From Elizabeth, the guns go to the National Rubber Machinery Corporation at Clifton, N. J., for additional recoil mechanism; then to the Erie Proving Ground for proof firing, and finally to the Cleveland Tank Plant, operated by the Cadillac Division of General Motors Corporation, for installation in the Bulldogs.

Outstanding features of the gun include a unique rifling method, the evacuator, and the muzzle brake. The evacuator mechanism permits discharge of up to 200 consecutive rounds without excessive accumulation of fumes inside the tank. The muzzle brake acts to deflect muzzle gas pressures backward and to counteract recoil. It is also an antiobscuration device. In this latter respect, tank guns often stir up clouds of blinding dust, keeping the gunner from observing the effects of his fire. The muzzle brake's gas-deflection action prevents this trouble from dust.

Synthesis Gasoline Plant

CONSTRUCTION of the world's first, modern, commercial, gasoline-from-coal synthesis plant will start in South Africa within the near future, it was announced by The M. W. Kellogg Company, refinery and chemical engineers of Jersey City and New York.

The plant, largest industrial project to be undertaken in South Africa since the last war, is being engineered and built for SASOL—South African Coal, Oil, and Gas Corporation.

Ltd. It will be located adjacent to the Vaal River, near the town of Coalbrook in the Orange Free State, about 40 miles south of Johannesburg.

The project is an integrated plant which embraces the opening of virgin coal deposits to supply raw material; the construction of above-ground gasification facilities to transform coal into synthesis gas; and the complete synthesis plant, heart of the project, to produce liquid hydrocarbons.

Kellogg's Synthol process is to be utilized in the synthesis step. This new perfected process differs materially from the processes used in previous synthesis plants for manufacturing gasoline and other liquid products.

The Synthol process is the result of research and development by Kellogg that started back in the thirties. Within the last few years this work has produced a radically new type of reactor to handle powdered catalyst as well as new fundamental operating conditions. These late developments, which improve both the economics and operability of the process, have been thoroughly tested in Kellogg's newest Synthol pilot plant in Jersey City.

The new SASOL Synthol plant is primarily designed to produce liquid fuels—gasoline and Diesel oil—in volume. While South Africa does not possess any major indigenous petroleum reserves, it does have tremendous deposits of coal available at low cost. Through use of the Synthol process, it is believed that these deposits can be utilized to make the country largely independent in the matter of liquid fuels.

High-octane-gasoline processes such as catalytic polymerization will form a part of the plant facilities. By-products of the new plant will be alcohols and oxygenated chemicals suitable for solvents and other uses.

Dollar-expenditure figures do not truly represent the magnitude of the project, inasmuch as a great proportion of labor and materials will be supplied from within the country.

Some indication of physical size is gained from the fact that just one of the several gas generators, used to transform coal into process gas, would supply the domestic needs of a U. S. city of 150,000 people.

Inasmuch as the new plant had to be adjacent to major new coal deposits, the project starts with virgin terrain. It must be built from the ground up, as well as from the ground down. Coal shafts must be sunk; coal conveying and grading machinery must be installed; a complete chemical processing plant, including bulk oxygen production, must be constructed; product-handling equipment, including a vast tank farm, must be built; a complete road net must be run; and in addition, an entire village to house the employees must be erected, complete with all facilities for living, education, and recreation.

Chemechol

THE development of a nonexplosive device for breaking down coal has been announced by the du Pont Company, Wilmington, Del. Called "Chemechol," it is a chemico-mechanical device which breaks coal from a mine face by the force of compressed gas generated by chemical reaction within the device and released mechanically.

The new device consists of a steel tube enclosing a chemical unit. The tube is closed at one end by a plug having electric connections, and at the other end by a rupturable disk held in place by a perforated head. After the tube is placed in a hole drilled in the coal face, the chemical reaction is activated by an electric current controlled within narrow limits. Heat is produced which after a few seconds destroys the starter wire, thus breaking the electric circuit. The chemical reaction thereafter continues to liberate gas which builds up to a predetermined pressure, at which point the disk ruptures. The gases rush out through the ports in the head and break down the coal. The tube, refilled in the mine with another chemical unit and disk, is used repeatedly.

The device produces no flame, according to the company. It cannot be activated by small electric currents, such as stray currents, nor by high currents such as mine lighting or haulage circuits. Chemechol units cannot be detonated by blasting caps or high-strength dynamite.

At the present time this new product is in the transition stage from the laboratory to extensive field testing. Field tests to date have been successful. It has produced a maximum of coarse coal with maximum safety and with a high degree of over-all efficiency. This new development, according to the company, is considered the most important for breaking down coal since the introduction of permissible explosives early in the century.

Coal-Burning Gas Turbine

IN a report in *Bituminous Coal Research*, January-March, 1951, on the status of the research program leading to the development of a coal-burning gas-turbine locomotive, J. I. Yellott, Mem. ASME, director of research of the Bituminous Coal Research Locomotive Development Committee, said that the past year has been devoted entirely to the testing of full-scale gas-turbine combustion and ash-removal equipment.

The most important phase of the work was that done with a Houdry turbine at Dunkirk, N. Y. This turbine, lent to LDC by the United States Bureau of Mines, was put into operation in November, 1949, as America's first full-scale coal-burning gas-turbine power plant. Three testing programs of 250 hr duration were completed during 1950, and a fourth program is currently under way.

The Dunkirk tests have been carried out with the use of combustion equipment developed as the result of a three-phase program. As a result of these co-ordinated investigations, a combustor has been developed which gives good efficiency over the entire range of operating conditions of a variable-speed gas-turbine power plant. The operation of two such combustors in parallel, which will be required in the first locomotive, was tested at atmospheric pressure and appears to offer no unusual or unexpected problems.

The problem of pressurizing pulverized coal, one of the essential features of the coal-burning gas-turbine power plant, has been solved by using a close-clearance rotary coal pump. This pump was also the result of a multiple investigation. These pumps will be used in conjunction with the power plant in a locomotive-size installation.

The feeding of pulverized coal from a storage tank into the rotary coal pump has been accomplished during the past year by various types of rotary feeders.

The most difficult part of the gas-turbine project has been the elimination of fly ash from gases from pressurized combustion of pulverized coal. This ash is much finer than conventional pulverized-coal ash. Its removal for turbine protection is an exceedingly difficult job. The turbine functioned satisfactorily with one fly-ash separation system, but after 500 hr of operation, it was found that excessive erosion had occurred in the first three stationary rows of turbine blades. The rotor blades were virtually undamaged, which led to the valuable conclusion that it is the stationary rather than the moving blades of a coal-fired gas turbine which must be given special protection.

As a result of a new fly-ash separation system developed during research under the Locomotive Development Program, virtually no dust larger than 325 mesh is being admitted to the

turbine, and it is expected that this extremely fine material will not be damaging. It is probable that the final solution to the ash problem will lie in using the best possible separator, in conjunction with erosion-resistant materials for the stationary blades. The rotor blades are apparently much less susceptible to ash erosion.

A second significant development was the arrival in Dunkirk of the Allis-Chalmers locomotive gas turbine. This turbine has been erected on a test bed, with the power plant for coal-handling equipment within locomotive space limitations. Loads up to 4500 hp can be put upon the turbine plant by air-blown resistors. Combustion and ash-removal equipment, similar to that tested with the Houdry unit, is now being completed by Alco Products Division of American Locomotive Company.

To summarize the technical position of the LDC program, feasible solutions have been found to the problems of supplying and burning coal under gas-turbine conditions. Component life must be improved, but more than 750 hr of operation have demonstrated that the equipment can do the job for which it was designed. The major remaining problem is the development of simple compact ash-removal equipment which can eliminate all 10-micron particles from the turbine inlet air.

15,000-Kw Gas Turbine

SALE of the largest gas-turbine generator yet ordered for the commercial generation of electric power was announced recently by the Westinghouse Electric Corporation, South Philadelphia, Pa.

The unit, a 15,000-kw machine, will be installed in the Bartlesville area of the Public Service Company of Oklahoma. Natural gas from the Oklahoma fields will provide the heat energy the new turbine will convert into electric power. It is scheduled for delivery from the Westinghouse Steam Division in about three years.

The 700,000-lb turbogenerator installation will consist of the gas turbine as the primary source of power, driving a hydrogen-cooled generator. The gas turbine will comprise high and low-pressure turbines driving high and low-pressure compressors, respectively, with the high-pressure turbine also connected to drive the generator. Intercoolers will reduce the temperature of the compressed air between stages of compression, and a regenerator will apply exhaust-gas heat to the air before it enters the combustor to reduce consumption of fuel.

The turbines will operate at a temperature of 1350 F, 300 deg higher than even the hottest steam temperatures in use today in electric-generating stations, and about twice as high as the temperature of the average steam-generating plant. Speed of the turbine will be 3600 rpm. At full load the compressors will draw in 7½ tons of air per min.

Liquid Ozone

RECENT advances at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill., prove that concentrated liquid ozone can be handled safely, and, as a fuel, may someday send rockets to the moon.

More than just a rocket fuel, however, ozone has other valuable military and commercial applications. It can be decomposed directly to oxygen for submarine patrols and high-altitude flying and is an ideal agent for water purification, air purification, and bleaching.

By demonstrating that ozone may be safely manufactured, scientists at the Foundation have opened the door for possible tonnage production.

Clark E. Thorp, chairman of the Foundation's chemistry and chemical-engineering department, reported progress in ozone technology recently, at a meeting of the Electrochemical Society in Washington, D. C.

Scientists have used fluorine, another powerful chemical, as an experimental rocket fuel. Although experiments with fluorine will continue, liquid ozone, which is practically as powerful, may provide the eventual solution.

According to Mr. Thorp, ozone is now much easier to handle than fluorine.

During World War II, German scientists worked overtime on an ozone-propelled rocket designed to bombard New York City from launching platforms over 4000 miles away. Luckily, the Germans were unable to discover the secret of handling liquid ozone without spontaneous detonation.

By replacing oxygen tanks with containers of liquid ozone, both planes and submarines would gain additional space with no sacrifice in oxygen volume.

Mr. Thorp explained that oxygen containing ozone gives off more usable oxygen per unit volume.

Used for water purification, ozone is a powerful chemical that literally "burns up" impurities without leaving an unpleasant taste. Large cities, such as Philadelphia and Paris, and smaller communities, including Whiting and Hobart, Ind., have used ozone water-purification systems for years.

An excellent deodorizing agent, dilute solutions of ozone in ventilating systems will overpower the smell of fish oils and rancid fats.

As a bleaching agent, ozone is superior to chlorine, hydrogen peroxide, and other liquid bleaches as it leaves no detrimental residue which ultimately decreases the strength of the bleached material.

Already in use in Europe as a bleaching agent, ozone works on paper pulp, blood, starches, and oils. It has also been used for oxidizing oils in the manufacture of linoleum.

Ozone can readily be made by bombarding oxygen with high-speed electrons. This technique duplicates nature's own method and explains why ozone can be smelled in the air immediately after a summer thundershower.

Many scientists credit ozone with making the sky blue, but this theory seems improbable since large quantities of oxygen probably produce the same effect.

Until two years ago our studies were as dangerous as they were interesting, Mr. Thorp recalled.

About one unscheduled explosion occurred per day until it was found that ozone could be made to behave by removing certain thermal, mechanical, electrical, and chemical sensitizing influences.

Today, planned explosions rock the laboratory as tiny drops of ozone are set off by remote control. Aluminum cups are mutilated by a drop of liquid ozone no bigger than the head of a pin.

Referred to by chemists as O_3, ozone molecules are composed of three oxygen atoms instead of the two atoms found in the air we breathe.

Originally, ozone research was sponsored by the Foundation, but since 1945 all work has been under the sponsorship of the Air Reduction Company.

Mobile Laboratories

LATEST of the mobile laboratories under test at the Engineer Research and Development Laboratories, Fort Belvoir, Va., is a Mobile Materials Laboratory able to support the construction of airfields up to and including 60,000-lb wheel loads in any theater of operation.

This laboratory will be used for the evaluation of existing

airfields as well as for the testing and evaluation of materials going into new road and airfield construction. It is intended as a replacement to the Soil, Asphalt, and Concrete Testing Sets of World War II.

The laboratory is designed to carry the minimum equipment necessary to run tests on soil, asphalt, and concrete. Equipment will include a "combination" testing machine capable of running California bearing ratio tests on soil, Marshall stability tests for asphalt design, and flexural strength tests on concrete. Also included will be a generous-sized drying oven, a compaction pedestal built into the floor of the van and supported from the ground by a separate jack, as well as a constant-temperature hot-water bath and sink with running water. An electric-power generator, capable of operating the heating, cooling, and testing equipment also forms part of the laboratory.

Among the tests which the laboratory makes possible are both laboratory and field in-place California bearing ratio tests, density and compaction tests on coarse and fine grain soil as well as the routine tests for classification of soils. In testing designs of asphalt mixes, the Marshall stability method is used. The flexural strength of concrete is determined by the standard three-point loading method. Evaluation of existing pavement is found by determination of dynamic modulus in place by a special electronic interval timer designed by Ohio River Division Laboratories.

Stepgage

A NEW kind of device which uses different colors to measure millionth-of-an-inch thicknesses, was described recently in Cleveland, Ohio, at the annual meeting of the American Chemical Society, by Dr. Katharine B. Blodgett, of the General Electric Research Laboratory at Schenectady, N. Y. Called a "stepgage," the new tool is used to measure thicknesses of materials occurring in the form of extremely thin films. An example of such films would be an ordinary soap bubble of the type that reflects iridescent colors.

According to Dr. Blodgett, the stepgage she developed is used like a yardstick, but in place of linear divisions are blocks of different colors, each of which, like the steps of a staircase, is higher than the one next to it. These blocks of color are mounted on a length of glass in the shape of a measuring rule.

In films a few millionths of an inch thick, colors vary with changes in thickness, so that a particular color indicates a particular thickness.

In using the stepgage, the color of a film of unknown thickness is matched to that block of color on the stepgage, which is the same or similar. A thickness reading, marked underneath that particular block of color on the stepgage, indicates the thickness of the unknown film.

Color blocks on the stepgage run from one-millionth-of-an-inch thick to 30 millionths, although gages with wider ranges can be made.

Explaining the process she developed for making the gages, Dr. Blodgett said that a solution of stearic acid is first spread over a surface of water containing barium, this solution spontaneously spreading out so finely that it is only one layer of molecules thick.

Then, by a dipping process, a special glass plate in the shape of a ruler is dipped in and out of the solution in such a manner that it collects coatings of the solution. Each coating represents a thickness of one layer of molecules. Ten such coatings applied result in a film on the glass plate one-millionth-of-an-inch thick which reflects one particular color.

The glass plate is then adjusted so that one portion of it representing the first block of color does not dip into the solution. The rest of the plate receives another 10 dippings and another 10 coats resulting in a film two-millionths-of-an-inch thick. The process is repeated until the desired range of thicknesses and colors is obtained.

Dr. Blodgett said the stepgage is proving a valuable tool in research work for determining not only extremely fine thicknesses but also for measuring ultralight weights. Knowing both thickness and density of a material, its weight can be computed. The gage is proving particularly useful in measuring materials which have been deposited on a surface by evaporation, she said.

Prestressed Aluminum Alloys

THE life of aluminum alloys that are subjected to vibration and other repeated or fluctuating stresses may be materially affected by applying stress to the material before it is placed in operation. Recent investigations at the National Bureau of Standards have shown that this treatment, known as prestressing, in some instances increased the fatigue life manyfold. This was especially noticeable at lower stresses when a comparatively small number of cycles of dynamic prestress were applied. On the other hand, there were cases in which little if any improvement resulted and at some stresses the fatigue life was shortened by the prestress. These studies were carried out by J. A. Bennett and J. L. Baker in the Bureau's mechanical metallurgy laboratory to evaluate the effects of both static and dynamic prestress on the fatigue properties of structural aluminum alloys. Similar studies have been previously made on aircraft steel.

A metal will often fracture when a pulsating load is applied for long periods of time, even though the maximum stress is much less than that which the metal can withstand, if the load were steady. This phenomenon, known as fatigue, is the primary cause of failure in machine elements and other structural members to which varying loads are applied in service. Because of this, fatigue properties of structural materials are important in the design of dynamically stressed structures. These properties are usually studied by applying a fluctuating load of constant amplitude to a specimen and counting the number of cycles which are required to fracture the specimen. In tests of aluminum alloys, it is not uncommon to find fractures occurring after as many as 500,000,000 cycles of stress, the number of cycles to fracture decreasing as the stress amplitude is increased.

One of the difficulties encountered in applying results of laboratory tests to practical construction arises from the fact that, in many structures, the stresses vary in a random manner. An airplane wing, for example, must support not only the weight of the plane, which is a steady load, but also a fluctuating load due to vertical gusts. To approximate this situation, the cumulative effect of fatigue stressing at two or more different amplitudes was evaluated, using aluminum-alloy sheet specimens.

Two means of prestressing were employed. In the first, a rather high static load was applied to the specimen before the start of the fatigue test. In the second, the specimen was stressed in the fatigue-testing machine for a predetermined number of cycles at one amplitude, and then carried to failure at a second amplitude. In this way data have been provided on the effects of both static and dynamic stress, applied prior to the fatigue test, on the fatigue properties of the material.

Conventional repeated-bending fatigue-testing machines were employed. In these machines one end of the specimen is held fixed in a vise while the other end is deflected up and down by means of an adjustable motor-driven eccentric and crank.

The design of the specimen, however, was new and was found to have several advantages over the usual type. Another innovation was a jig which measured the specimen before testing and automatically located the point at which the stress in the specimen would be a maximum.

The static prestress studies were made with Alclad 24S-T sheet and all fatigue tests with this group of samples were operated in unidirectional bending; that is, the specimen was bent in only one direction from the no-load position. First, a sufficient number of specimens were tested without prestress to give the typical relationship between stress amplitude and number of cycles to fracture for the original material. Then a static load was applied to the remainder of the specimens before starting the fatigue test. In some cases the bending load in the fatigue test was in the same direction as the static load; in others these directions were opposite.

At the higher test stresses, (25,000, 30,000, and 35,000 psi), the effect of the static prestress was negligible. However, at the test stress of 20,000 psi, there was an appreciable decrease in life for the specimens prestressed in the direction opposite to that of the subsequent fatigue stress. On the other hand, there was a slight increase in life for the specimens with a prior static stress in the same direction. The net result was a 10-to-1 difference in life between these two sets of specimens.

The tests for evaluating the effect of dynamic prestress were made on specimens of bare 24S-T sheet. The fatigue loading was applied in completely reversed bending, that is, the specimens were deflected equally to each side of the no-load position. The prestress amplitude was applied for a given number of cycles before the specimen was carried to failure at the test stress. Three values of prestress amplitude were used and four test stresses.

At the two higher prestress amplitudes (22,500 and 32,500

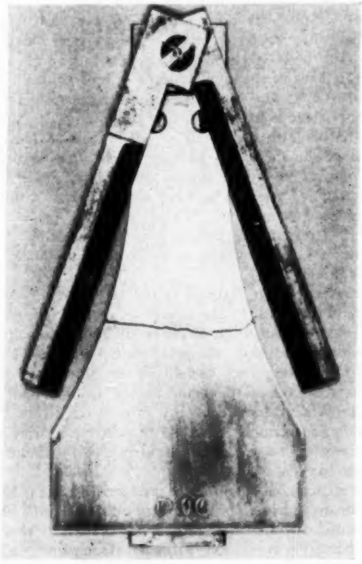

FIG. 4 FATIGUE-TEST SPECIMEN OF ALUMINUM ALLOY IN SPECIAL MEASURING JIG

(Jig measures specimen before testing and automatically locates the point at which the stress will be a maximum.)

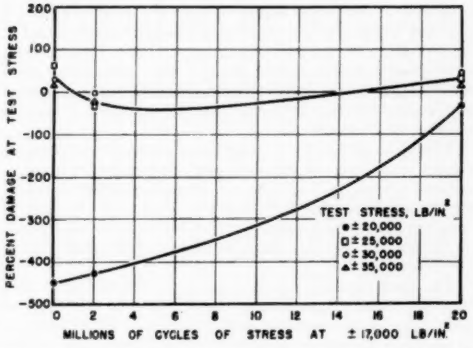

FIG. 5 EFFECT OF DYNAMIC PRESTRESSING AT 17,000 PSI ON FATIGUE STRENGTH OF 24S-T ALUMINUM-ALLOY SHEET

psi), fracture occurred earlier in the prestressed samples than in the original material. It seems, therefore, that a portion of the fatigue life of the alloy is used up by the prior stress. Within experimental error it was found that this portion was approximately equal to the ratio of the number of cycles run at a given prestress to the number of cycles which will cause failure at that stress.

For the lowest prestress, however, (17,000 psi) the behavior was entirely different. At a slightly higher test stress (20,000 lb), there was a noticeable improvement in the life of the specimens. Two thousand cycles and 2,000,000 cycles of prestress produced an increase of more than 400 per cent. Even at 20,000,000 cycles, the increase was of the order of 33 per cent.

The immediate importance of this work is the possibility of improving the fatigue life of structural members by prestressing. Of more fundamental significance, however, is the aid it may offer toward determining the mechanism of fatigue failure in metals.

Titanium Production

MILITARY demands for titanium may stimulate production of this versatile metal into real tonnage figures, if current development projects show promising results, it is stated in the *Industrial Bulletin* of Arthur D. Little, Inc., April, 1951. While total titanium production in 1950 was only 120,000 lb, a recent military order called for 75,000 lb, and production by the end of the year rose to the rate of 550,000 lb annually. If cheaper and more efficient production methods can be put into widespread use, thus reducing the price of the metal, a market is ready for greatly increased output, the *Bulletin* points out.

Even at current prices of $5 a lb for "sponge" metal, $7 a lb for ingot, or $15 for sheets in quantity, titanium's unique properties offer advantages which sometimes outweigh the cost. Some authorities predict widespread use and a price of $1.50 a lb for sponge in the foreseeable future. Titanium's advantages for military applications are its lightness combined with strength and its resistance to corrosion. The largest projected use of titanium is as structural members in aircraft. Nonstructural parts for aircraft, such as de-icing ducts and fittings, are already in production. Ordnance is also interested in titanium. A titanium base for an artillery mortar, for example, weighs only 24 lb, compared with almost twice as much for the alloy steel which is now used. For naval use, titanium's resistance to corrosion by sea water is an advantage.

Because of titanium's high melting point, 3150 F, it was at one time hoped that the metal would be particularly useful in jet aircraft, rockets, and similar applications. Experiments have shown, however, that strength falls off rapidly above 800 F, and at about 1000 F irreversible absorption of oxygen and nitrogen causes embrittlement of the metal. Suitable alloying may overcome this.

Although the two U. S. commercial producers are planning further increases in capacity, the problem of producing titanium remains serious. A high plant investment of $1500 an annual ton is needed for the Kroll process of reducing the original titanium compound to usable metal, excluding the cost of plants to produce the starting compound and the magnesium used in the process.

The Kroll process starts with titanium tetrachloride. This may be obtained from treating the ore directly with chlorine and carbon or by treating titanium dioxide, which has been extracted from the ore with acid. The tetrachloride is then treated in a heated reactor, with magnesium as a reducing agent, where the magnesium is substituted for the titanium salt, leaving metallic titanium. A technical and economic drawback to the process is the fact that the titanium metal produced is in a sponge which must be separated from the remainder of the mass—usually by distilling off the magnesium chloride at low pressures—before being converted into dense ingots. The metal is generally melted and cast into ingots in a vacuum furnace or in an inert atmosphere, such as argon, because the molten titanium is reactive with air. Alternatively, the sponge metal may be compressed into ingots.

The ideal process would permit reduction of a titanium compound to metal in usable form directly, but the only process which accomplishes this at present does not appear to be commercially feasible. When titanium tetraiodide is placed in a vacuum adjacent to a hot filament, it will decompose and deposit crystals of pure titanium on the filament. The process is used in laboratories to produce small quantities of pure titanium for research purposes, but nobody has discovered a way to translate this laboratory method into a full-scale plant-production process.

Another process is that of a Canadian company, which has been reported to produce titanium by direct reduction of titanium dioxide with calcium metal. Savings are said to be possible because this oxide is a cheaper form of titanium than the chloride compound used as the starting material in the Kroll process. The higher cost of calcium in comparison with magnesium would, however, offset these savings. Some experts, moreover, believe that production of a titanium free of oxygen would be difficult.

One of the more encouraging factors in the long-range picture for titanium is its comparative abundance, the *Bulletin* states. It ranks ninth among the elements in the earth's crust, and it has been estimated that the known reserves in North America contain 110 million tons of metal. An important deposit is in Quebec, where a deposit of ilmenite (an ore containing both titanium and iron) is estimated at 125 million tons. The first of five stationary electric-arc furnaces has been put into production for a high-titanium-bearing slag, along with a high-grade melting steel. Present plans call for bringing in the remaining furnaces by mid-1952. The plant will then produce 250,000 tons of slag containing approximately 70 per cent of titanium dioxide and 200,000 tons of high-grade iron. The titanium dioxide will be shipped to pigment manufacturers in the United States, who presently consume over 99 per cent of the titanium dioxide produced. The slag from the Quebec furnaces is highly suitable both for the acid treatment to obtain titanium dioxide and for other methods of obtaining titanium compounds. Since the iron content is somewhat lower than in other sources, less acid is required to remove the iron. While titanium metal is not being produced, here, ample power at this location would make it feasible for the future.

A leading U. S. producer of titanium-dioxide pigment has expanded its production facilities. The same company has also leased several buildings in Nevada, presumably for the production of titanium metal, and 151 million kwhr of electric power have already been allocated for it.

High-Speed Propellers

BRITISH designers are now breaking fresh ground with propellers of new shapes and sizes to transmit the enormous powers of the latest gas-turbine engines, according to The Society of British Aircraft Constructors.

For example, the de Havilland Propeller Company, Hatfield, England, is now running on the test bed an eight-bladed contra-rotating propeller which will give about the same thrust at take-off as all four pure jet engines of the Comet put together.

Engineers at Hatfield are also studying designs for blades which will operate efficiently on aircraft cruising at 600 mph. These propellers, whose blade tips would be traveling at $1\frac{1}{2}$ times or twice the speed of sound, would probably be wafer-thin steel four-blade units giving high take-off thrust with very economic fuel consumption at high speed.

With the high horsepowers of the present day, the designer's problem is one of weight. He is forced to increase the blade area to such a point that it is impossible to use conventional duralumin material and still keep within a reasonable weight limit. The problem is particularly marked with propellers of more than about 14 ft in diam. Wood, the other customary propeller material is, of course, far too weak.

Several solutions have been suggested but current research at Hatfield has centered on the hollow-steel blade. This blade is said to save some 12 to 15 per cent in weight over any solid alloy blade of the same design and gives 20 per cent more static thrust than any solid airscrew of the same weight.

The new blade is made by fitting a tubular steel core into a thin outer-blade-shaped shell of sheet steel. The core is sheathed in the shell in a 1000-ton press after heating in an electric furnace and then shaped by filling it with nitrogen under pressure. The gap between core and shell is filled with a rubber foam compound. When the whole blade has been sealed, the root end is hardened in an induction heater to give a hard surface which will restrain the blade against centrifugal load.

The heater used at Hatfield is the largest in England, and probably in the world. The advantage of this type of heating is that it can be turned on or off by flicking a switch and can be completely localized—the principle being that the machine induces a high-frequency current in the object to be heated. Thus the root-end of the blade can be heat-treated without affecting the temperature of any other part of the blade or material. For example, it would be possible to heat a nail in a paper bag up to several hundred degrees without burning the paper bag.

The precision checking of each production blade is backed by a complicated series of bench tests and vibration checks of experimental and finished propellers. Proof of this is that whereas the de Havilland Propeller Company built about 1500 production propellers last year, they also ran another 265 propellers for a total of 7400 hr for development.

The tests are designed to put a propeller through all the conditions of service before it actually goes into airline or Service operation.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Industrial Pollution

Air Pollution—A Problem of the Process Industries, by A. G. Christie, Fellow ASME, The Johns Hopkins University, Baltimore, Md. 1951 ASME Process Industries Division Conference paper No. **51—PRI-10** (mimeographed).

THE contamination of the atmosphere is due to many causes, not all of which are understood by the public. There is no pure air in nature. It contains wind-borne dusts, pollens, odors, and gases from natural sources. The following are man-made contributions to air pollution: Automobile and truck exhaust gases, winds carrying dust, trash fires, smokes from chimneys of industrial and home units, fumes, odors, and dust discharges from factories.

Impurities discharged from process industries have included smokes from fuel-burning furnaces, dusts from such processes as cement, lime, mineral wool, iron and steel production, rock crushers, and others; also gases from chemical plants, paint factories, smelting plants, etc., and odors from packing plants, chocolate factories, bakeries, etc.

Many process plants have installed smoke-prevention equipment and dust catchers. The electrical utilities have been and are conscious of public opinion and are generally interested in civic betterment. They have led in the installation of this equipment and now no new central station is designed without such devices. A considerable part of the decrease of visible smoke from such plants is due to improvements in fuel-burning equipment and furnace construction.

Gases, vapors, and odors from process plants contribute to air pollution. Certain odors are not in themselves offensive yet even the persistent smell of a food-processing factory may become obnoxious if prevalent all of the time in a neighborhood.

Certain gases and vapors from process industries are objectionable due to their destructive action on vegetation or their corrosive character. Much has been done in the metallurgical industries to lessen the discharge of such gases. Chemical industries are frequently faced with the problem of gas or vapor emissions of an obnoxious nature. Other industries have similar problems.

Many process industries use chemicals and solvents from which certain gases and vapors escape through chimneys or vents into the atmosphere. These may be caught in cooling, washing, or absorption processes and may possess commercial value. In other cases, their recovery may prove expensive yet necessary. It is not sufficient to wash these gases or vapors from the air only to form foul-smelling water courses in which fish cannot live.

Managers of process industries must also consider whether their products contribute to air pollution in the hands of their customers. For instance, automobiles and trucks contribute largely to air pollution in cities, due to exhausts fouled by smoke, carbon monoxide, and other gases, often due to improper engine adjustment. Engine builders should study the problem of complete combustion under all operating conditions or, if this is impossible, of developing a catalyst to oxidize the carbon monoxide in the exhaust gases on which problem some work has already been done.

Both ordinance administrators and plant operators are handicapped by the lack of simple standards to measure air pollutants. The Ringelmann chart used for smoke measurement has many faults and is little good on dust or gaseous discharges. Visibility alone is an uncertain standard. The ASME Code on smoke measurement involves a lengthy test. Meters based on light intensity through a gas column have merit for smoke or dust measurement. At present there are no standards for gases and odors and no simple means of measuring their amounts. Much development of standards remains to be done.

Automatic Recording and Control as Applied to Some Industrial-Pollution Problems, by W. N. Greer and R. K. Davis, Leeds & Northrup Company, Philadelphia, Pa. 1951 ASME Process Industries Division Conference paper No. **51—PRI-3** (mimeographed).

SINCE at present there is no established index of pollution, SO_2 concentration is

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usually considered a good index of the degree of industrial contamination of the air. Because of the prevalence and relative ease of measurement, SO_2 is generally accepted as the best criterion of possible air pollution.

SO_2 contamination of the atmosphere and its effect on vegetation was studied by Dr. Moyer D. Thomas and his associates of the American Smelting and Refining Company back in the 1920's and resulted in the development of the Thomas SO_2 autometer.

This instrument, as manufactured today by L&N, is entirely automatic in operation and records concentration directly in parts of SO_2 per million parts of air. An appreciable number of these instruments are now being used in air-pollution problems not only by industry but also by state and federal agencies.

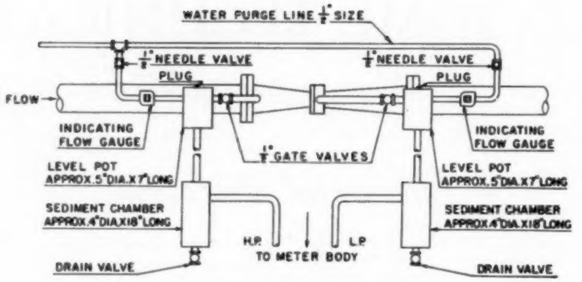
While the measurement of appreciable concentrations of SO_2 in air is a simple operation, the automatic measurement of a few parts per million to a reasonable degree of accuracy is not so simple.

Unlike most gas-analyzing equipments, the Thomas autometer employs electrolytic conductivity as a means of measurement. A continuous sample of air is pumped countercurrent to the flow of a 2 to 4×10^{-3} molar hydrogen peroxide in 5×10^{-6} normal sulphuric acid solution in an absorbing column where SO_2 is absorbed and oxidized to the sulphate ion. The resulting change in electrolytic conductivity of the solution is detected by a conductivity cell and is recorded directly in parts of SO_2 per million parts of air on a continuous chart by means of a Speedomax recorder. The measuring circuit employed is a conventional a-c Wheatstone bridge.

Performance characteristics of the autometer are discussed. Some recent improvements in the equipment are illustrated. Factors governing the controlability of neutralization of industrial wastes by pH control as well as by oxidation-reduction control on specific waste treatments are considered.

Flowmetering Equipment for Measuring Industrial Wastes, by G. Newberg, Brooklyn, N. Y. 1951 ASME Process Industries Division Conference paper No. **51—PRI-4** (mimeographed).

THIS paper discusses the characteristics of the principal primary elements and instruments used to measure liquid flow, with emphasis placed on devices applicable to the measurement of sewage and industrial wastes. It provides a basis for solutions to some of the problems encountered in flow measurement, particularly where corrosive liquids or solids in suspension are to be considered, as they must be in nearly all waste-disposal installations.



WATER PURGED SEWAGE FLOWMETER INSTALLATION

Meters for sewage and waste flow measurement fall into three general classifications. The first class consists of differential head meters used to measure flow in completely filled pipes. It includes such primary devices as Venturi tubes, flow nozzles, orifice plates, and Pitot tubes, as well as differential measuring devices. The second group is composed of so-called area meters which also are useful for measuring flow in completely filled pipes. The third group comprises head-area meters. They are used to measure flow in partially filled pipes or in open channels. The parabolic flume, the weir, and the Parshall flume are in this group.

The type of flowmetering equipment chosen depends entirely on the physical conditions surrounding each installation. The correct flowmeter for one installation may not be suitable for a similar application if it is moved only 20 ft downstream. The problems encountered are manifold, and there may not always be a possible solution within the framework of existing conditions.

In specifying instruments for a given application, the meter manufacturer will need to know all the conditions involved. If the application requires special consideration with respect to corrosion, head loss, or solids in suspension, he will advise the best form of primary element and meter for the particular application.

Control of Pollution in the Port of Baltimore, by T. D. Conn, Mem. ASME, Bureau of Harbors, Baltimore, Md. 1951 ASME Process Industries Division Conference paper No. **51—PRI-7** (mimeographed).

THE Port of Baltimore has been plagued by oil pollutions over a period of years, probably to a much greater extent than many of the other large ports in the United States, because a physical condition exists here under which there is practically no current flow in the river, especially in the northwest branch, and there is only a mean average of 1.2 ft variation in tide level. Therefore, with no normal flow tendency to carry the oil slick pollutions downstream, they remain static, only to be shifted about from one side of the harbor to another, and possibly back again, by the various changes in the direction of the wind.

Disastrous fires are, of course, some of the major perils to be feared as a result of the oil slicks, and added to these, are the enormous expense and inconvenience suffered by many individuals and port industries.

The Bureau of Harbors has received wholehearted co-operation from all agencies in its educational campaign to reduce pollution. This Bureau prepared warning notices, printed in 6 languages, and is distributing them as widely as possible. The U. S. Agricultural Department and the Association of Maryland Pilots have distributed copies to all incoming ships, as their representatives have met them entering the Bay at the Capes, at Norfolk, Va., and at the C. & D. Canal. All of the steamship agencies have furnished copies of these notices to their ship captains and other personnel, and have posted copies at all their piers and terminals.

In connection with the detection and investigation of oil-pollution cases, the Bureau sometimes resorted to an analytical comparison of the oil slick with that of a sample taken from the suspected ship, when it was not possible to get a sample at the time the oil was actually coming from the ship.

After the oil slicks appeared, very little could be done to rid the harbor of them. Attempts, with only partial success, were made to separate, or break up the slick, by means of hose streams from one of the fireboats, or a tug, and

when at close range by land hose lines.

Recently several companies demonstrated methods for the removal of oil from the surface of the water with the use of patented materials.

These materials were quite similar and consisted generally of a grade of finely divided sand that had been coated by mixing in a solution containing a high carbon content which adhered to the sand, and then heat-treated or roasted in a kiln type of furnace. This fine granular material is applied to the oil slick by dusting or spreading a light coat of it evenly over the surface of the oil.

Shortly after the material makes contact with the oil, it combines apparently as a mechanical mixture forming tarlike clusters and masses. These are slightly heavier than water and slowly sink. Agitation of the water surface speeds up the sinking process.

It is claimed that the oil cannot separate again and will not return to the surface.

The Bureau has not been highly in favor of these processes, the principal reasons being the high cost of the material itself, the difficulty of handling it, the amount of equipment necessary, and slowness of the operation, which may even require a second application to obtain desired results.

Serious thought was given to designing various kinds of portable equipment which would be able to pick up and remove the oil from the surface of the water.

A U. S. Navy surplus-oil-recovery barge was obtained for possible use, and with minor overhauling, the equipment was successfully placed in commission.

A specially constructed and adjustable intake pipe slotted lengthwise, having top and bottom fins, set at about 45 deg apart, with the slot between them forms part of the equipment. It is adjustable to the water level and has proved successful in use.

The intake pipe is adjusted so that the slot is at the level of the surface of the oil to be collected. An air compressor creates a partial vacuum in the tanks. The oil in contact with the pipe, combined with a variable quantity of water, is then drawn through the system and into the vacuum tanks where it remains until they are practically filled.

When this stage is reached, the mixture of oil and water is pumped up from the vacuum tanks into the large settling tank, located upon the deck of the scow. This tank is approximately 7 ft in diam × 6 ft deep and has a cone bottom—the capacity of the tank being 1800 gal.

The collection cycle is continued—oil being again collected in the vacuum tanks—pumped up into the settling tank, and so on. The gravity-separated water, which contains no oil, is occasionally drained overboard from the tank. This routine is continued until the settling tank has become filled with the oil residue.

Disposal of the oil after collection was another problem, but an agreement was finally reached whereby the barge was sent to the dock of a local refinery, where the slop oil was pumped into recovery pipe lines and ultimately refined. There is no salvage value to this oil, as the cost of processing it is equal to or greater than its real value.

Drying and Atmospheric Pollution, by A. M. Lane, Jun. ASME, Wyssmont Company, Long Island City, N. Y. 1951 ASME Process Industries Division Conference paper No. **51—PRI-1** (mimeographed).

IN drying operations, the problem reduces itself to four basic considerations: (1) Physical characteristics of the material to be dried both in the wet and dried forms, (2) handling of the material during the drying cycle, (3) entrainment of dust in the exhaust from the drier, and (4) separation of the dust from the drier exhaust gases.

The physical characteristics of the particular product being dried is a major factor in determining the seriousness of atmospheric pollution by dust from drying operations. Generally speaking, the wet feed contains sufficient moisture to act as a binder for all the finer particles regardless of the particle size, thereby presenting no dust problem. Before feeding into a drier, pasty material may be preformed by one means or another into relatively coarse granules. In some instances, however, the feed stock may be a fine free-flowing powder containing relatively little moisture which has no binding value and, consequently, such a product would present a dust problem from the beginning of the drying operation.

The handling that a material is subjected to during its drying cycle is a major cause of dust problems arising in drying operations. Each type of drier has its own particular means of conveying or handling.

The quantity of air required to evaporate a given quantity of water is an important factor in dust control of drying operations. Obviously, the larger the amount of water picked up by the air, the smaller the air quantity required. Smaller air flows for a desired dried material production result in smaller overall dust losses from the drier, and smaller more efficient dust collectors may be used.

The final stage in the problem of reducing atmospheric pollution by drying operations is the separation of the dust-bearing gases leaving a drier. Any of the various types of dust filters and collectors can be employed for this purpose, the actual choice being dependent upon economics and recognition of certain limitations in each collector when handling drier exhaust gases.

The Protection of Closed Vessels Against Internal Explosions, by E. W. Cousins and P. E. Cotton, Factory Mutual Laboratories, Boston, Mass. 1951 ASME Process Industries Division Conference paper No. **51—PRI-2** (mimeographed).

MANY pieces of industrial equipment, such as mixers, churns, reactors, and autoclaves may unavoidably contain mixtures of combustible gas or vapor with air and thus are subject to the hazard of internal explosion. For gases and vapors likely to be encountered in industry such data as can be found indicates that the maximum explosion pressure, in terms of absolute pressure, averages about eight times the initial absolute pressure with some variation with material and initial pressure. In terms of "gage" pressure this maximum explosion pressure would be eight times the initial gage pressure plus 105 psi. It is therefore obvious that any equipment designed in accordance with the ASME "Code for Unfired Pressure Vessels" with a rupture strength five times the working pressure would be destroyed by an internal explosion.

If a vessel is to withstand an internal explosion without damage the maximum stress must not exceed the elastic limit, which for ordinary steel is about 50 per cent of the ultimate strength. The bursting strength therefore must be at least twice the maximum explosion pressure. In most cases this would be prohibitive. For example, a tank operating at 25 psig would be normally designed for a bursting strength of 125 psig, but the maximum explosion pressure would be 305 psig requiring a designed bursting strength of at least 610 psig. The metal thickness required would therefore be at least five times normal, and, if because of the rapid application of stress a further factor of two is required, the metal thickness becomes ten times normal.

If the maximum pressure is permitted to develop, it is not economical to build tanks or similar vessels to withstand without damage an internal explosion. The maximum pressure can be reduced by using rupture disks to relieve the explosion. Data supported by tests are pre-

sented to permit design of disks for various sizes and strengths of vessels for various gases and vapors.

The Utilization of Pollutive Wastes in the Process Industries, by D. F. Othmer, Mem. ASME, M. D. Weiss, and R. S. Aries, Mem. ASME, Polytechnic Institute of Brooklyn, N. Y. 1951 ASME Process Industries Division Conference paper No. **51—PRI-11** (mimeographed).

THE increasing severity of the Water Pollution Control enforcement program and the decreasing amount of fresh water available to industry has led to the search for new methods of utilization of the materials which ordinarily would be discharged as a pollutive waste. The method of utilization of a waste material is economically the most satisfactory but technically the most difficult, calling upon the best skills of chemist, chemical engineer, mechanical engineer, and marketing expert.

Each industry has developed a utilization program along its own lines. In the food industries, packing-house wastes have been converted to valuable rare organic chemicals, dairy-plant wastes to new food products. Valuable growth factors have been discovered in the former wastes of the fermentation industries which are now being utilized as stock feed. Wastes from the petroleum industry are utilized as fuel and in fertilizer manufacture, from the blast furnace in fertilizers, from metal plating as a source of inorganic chemicals. Synthetic tanning materials have been made from the wastes of the naphtha industry. The pulp and paper industry as the culmination of a long research program seeking utilization of the wastes of the sulphite pulping process has developed products ranging from road binders to synthetic vanillin.

Mobilization of the resources now discarded as pollutive wastes will go a long way toward solving the industrial water-pollution problem.

Water Pollution by Industry—A Survey of State Legislation and Regulations, by D. F. Othmer, Mem. ASME, M. D. Weiss, and R. S. Aries, Mem. ASME, Polytechnic Institute of Brooklyn, N. Y. 1951 ASME Process Industries Division Conference paper No. **51—PRI-8** (mimeographed).

THE regulation of industrial pollution has received increased attention during the last decade. At least 29 states have adopted new legislation, revised existing legislation, or modified associated regulations since the publication of the last legislative survey. These changes, often in basic policy, are of tremendous import to the industries located within the borders of the state. The cost of waste treatment, a function of the nature of the waste, is also dependent upon the requirements of the state with respect to waste-treatment effluents.

An extensive report of the findings of a survey of state legislation and regulations has been published. This paper is a summary of the broader findings of that survey which included data from all the states and territories of the United States with the exception of Wyoming and Colorado.

Although the Federal Government has had some form of pollution-control legislation since 1899 as part of River and Harbor legislation, it was not until the adoption of the Water Pollution Control Act of 1948 that a separate program was established for this purpose. The new legislation put into words the policy of co-operation that had been practiced by the previous enforcement agency and it furnished funds for aid to interstate, state, and municipal agencies in the formulation and execution of their pollution-control problems.

The Water Pollution Control Division of the Public Health Service has been established to carry out the provisions of the 1948 Act. One of the many activities has been to strive toward the attainment of uniform water-pollution legislation among the states. An outline of such legislation has been discussed in detail in the previously mentioned survey. The outline has resulted in a more uniform approach to pollution-control legislation despite the major differences in the actual pollution problems in the states.

Restoration of the Schuylkill River, by Frederick H. Dechant, Philadelphia, Pa. 1951 ASME Process Industries Division Conference paper No. **51—PRI-6** (mimeographed).

THE restoration project of the Schuylkill River had five principal objectives, according to U. S. Engineering Department surveys:

1 Abatement of the discharge of the wastes from mining to the river and its tributaries.

2 Arresting of the silt burden caused by erosion from the bed, banks, and culm piles in the mining fields, from being transported downstream.

3 Reduction in the height of flood stages of the river.

4 Improvement in the quality of the river water.

5 Restoring the recreational value of the river.

The general plan of improvement prepared by the Army Engineers and submitted with their report of survey in 1945 furnish a guide for the more detailed studies made by the Engineers.

The plan recommended by the Engineers and approved by the Water and Power Resources Board modified the Army Engineers' plan of 1945 in certain important details, and the adopted plan will be described in outline.

Visualize the Schuylkill River having two main branches above Hamburg, the main one bearing northwest and the Little Schuylkill bearing northeast. On each of these branches the plan called for the construction of desilting basins formed in the river channel, and a third desilting basin in the river channel below the confluence of the two branches. These three desilting basins are called Auburn on the main branch, Tamaqua on the Little Schuylkill, and Kernsville on the main river below the confluence. To understand the function of these basins one should see the millions of tons of waste materials piled within the mining region, which is subject to erosion and carriage to the river. These desilting basins provide the means of trapping the eroded silt, from which it can be removed by dredging to impounding basins.

The plan then called for the removal from the river channel and its banks the deposits of culm for the restoration of the original waterway and the consequent lowering of flood stages. This part of the plan involved also the removal of eleven of the old and partly demolished stone and timber crib navigation dams and the construction of silt-impounding basins for the storage of the culm dredged from the river.

The last phase of the plan called for rectification of the channel by the removal of obstructions and some of the old canal locks which encroached the channel and obstructed the passage of flood waters. In addition, this phase intended to improve conditions for better recreational use of the river.

How Industry Can Aid to Prevent Stream Pollution, by E. B. Besselievre, The Dorr Company, Stamford, Conn. 1951 ASME Process Industries Division Conference paper No. **51—PRI-5** (mimeographed).

THERE are four steps by which industry can aid in the prevention of stream pollution: Co-operating with the local authorities when confronted with a problem, and in a spirit of willingness; making proper economic studies to produce the desired results at a reasonable cost; studying the means of utilizing

by-products, and engaging competent specialists to solve their problems, thus assuring satisfaction to the local authorities, and economy and savings to them.

No authority will willingly compel an industry to go further than necessary in providing treatment works, but it requires intelligent co-operation between the parties interested—the industry and the authority—to find out just what is needed. That is why it is important to have, as one of the conferring group, an engineer skilled in waste-treatment problems, so that he can ask intelligent questions and arrive at a sensible basis for action.

After having determined just what the authority requires, it is up to the engineer to design a plant to accomplish that object.

However, certain preliminary steps should be taken. The engineer should, with the complete co-operation of the industrial-plant management, make a survey of the industrial plant itself to determine whether or not there can be some modifications or changes in methods or processes which will eliminate or reduce some of the annoying wastes in the plant. Frequently such a study will bring out improvements in plant practice which will materially reduce the volume and strength of wastes. Whenever this can be done, the cost of treatment will go down.

And frequently, not only will the cost of treatment be lessened by the lesser volume of wastes, but important internal economies may be achieved which will reduce production costs. The recycling of wastes to the process, having recharged them to bring up their strength, frequently reduces the total daily amount of chemical products required.

Having made a plant survey and having reduced the volume and strength of the wastes, the next step is to make a study of adjacent industries, to gain a knowledge of the characteristics and nature of their liquid wastes, or even in some cases, their solid wastes. Frequently, adjacent plants, each of which may be producing a waste which cannot be discharged into the local stream without increasing the pollution, may be able, by combining their wastes, to achieve a degree of pollution reduction which will materially decrease their individual costs for plant and daily operation. One plant will produce an acid waste and an adjoining one, an alkaline waste. The plant having the alkaline waste may also have a problem of color removal or reduction.

Frequently the addition of the acid waste to the alkaline one will produce the necessary neutralization. This will cause the precipitation of the color and much of the suspended matter. At the same time, the acid waste is neutralized by the alkaline so that the mutual mixture may be in such condition that it can be discharged into the stream without further treatment.

The greatest cost in industrial waste treatment is not necessarily the first cost of the plant to treat the wastes but in the daily costs for coagulants, chemical precipitants, or other compounds. If the need for these can be lessened by utilizing the wastes of an adjacent plant, the costs of both plants may be reduced.

An additional economy in this combining of wastes is also obtained in the initial cost of plant. By combining two or more wastes, the total plant cost for each will seldom be as much as it would be if they each built their own plant. Likewise, the cost of superintendence, electric current, lubricants, repairs and maintenance, fixed charges, are all lowered for the individual entities composing a group.

Mechanics

On the Inextensional Theory of Deformation of a Right Circular Cylindrical Shell, by R. M. Hermes, Mem. ASME, University of Santa Clara, Santa Clara, Calif. 1951 ASME Applied Mechanics Division West Coast Conference paper No. 51—APM-2 (in type; to be published in the *Journal of Applied Mechanics*).

THE inextensional theory of bending of shells is considered. By the method of superposition the known solution is extended to include two cases which can easily be investigated experimentally. The experimental results are compared with the theoretical solution, indicating the degree of approximation involved in the use of the inextensional theory.

The conclusion to be drawn is that the theory of inextensional bending of cylinders is open to considerable doubt and that any solution based upon this theory warrants experimental verification before acceptance.

Bending of Thin Ring Sector Plates, by L. I. Deverall and C. J. Thorne, University of Utah, Salt Lake City, Utah. 1951 ASME Applied Mechanics Division West Coast Conference paper No. 51—APM-1 (in type; to be published in the *Journal of Applied Mechanics*).

GENERAL expressions for the deflection of plates whose plan form is a sector of a circular ring are given for cases in which the straight edges have arbitrary but given deflection and bending moment. The solutions are given for all combinations of physically important edge conditions on the two circular edges. Sectors of circular plates are included as special cases. Solutions are given for a general load which is a continuous function of r, and a sectionally continuous function of θ, where r and θ are the usual polar coordinates with the pole at the center of the ring. Several specific examples are given.

ASME Transactions for June, 1951

THE June, 1951, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members, $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Vibration of Rectangular and Skew Cantilever Plates, by M. V. Barton. (50—A-12)

Free Vibrations of a Pin-Ended Column With Constant Distance Between Pin Ends, by David Burgreen. (50—A-9)

Axially Symmetrical Plates With Linearly Varying Thickness, by H. D. Conway. (50—A-6)

Large-Deflection Theory for Plates With Small Initial Curvature Loaded in Edge Compression, by J. M. Coan. (50—A-2)

Some Thin-Plate Problems by The Sine Transform, by L. I. Deverall and C. J. Thorne. (50—A-13)

The Limit Design of Space Frames, by Jacques Heyman. (50—A-4)

Analysis of Deep Beams, by H. D. Conway, L. Chow, and G. W. Morgan. (50—A-7)

A Fourier Integral Solution for the Plane-Stress Problem of a Circular Ring With Concentrated Radial Loads, by Carl W. Nelson. (50—A-16)

The Torsion of Elastic Spheres in Contact, by James L. Lubkin. (50—A-1)

Influence of Flame Front on the Flow Field, by H. S. Tsien.

Buckling of a Sandwich Cylinder Under Uniform Axial Compressive Load, by A. Cemal Eringen. (50—A-3)

The Propagation of Longitudinal Waves of Plastic Deformation in a Bar of Material Exhibiting a Strain-Rate Effect, by L. E. Malvern. (50—A-18)

DESIGN DATA

The Rectangular Plate Subjected to Hydrostatic Tension and to Uniformly Distributed Lateral Load, by R. F. Morse and H. D. Conway.

DISCUSSION

On previously published papers by H. J. Gough; R. S. Ayre and L. S. Jacobsen; W. Forstall, Jr., and A. H. Shapiro; Joseph Marin and B. J. Kotalik; W. M. Dow; R. D. Mindlin and L. E. Goodman; W. A. Nash; W. T. Thomson; Chia-Shun Yih; Dana Young; J. A. Joseph and J. S. Brock; and W. R. Osgood and J. A. Joseph.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Return on Investment

Comment by T. W. Hopper[1]

The members of the Society probably could spend more time to advantage considering the composition of savings and the meaning of such terms as "pay-off period" in connection with engineering projects and problems. This paper[2] is both stimulating and of value in considerations of this timely subject.

The author describes the pay-off period (called by other similar names) as the number of years to be used as a guide in recommending a choice among alternatives. This rule of thumb is determined by dividing the extra investment by the reduction in expenses or prospective saving. This nomenclature is considered adequate if the variables contained in the definition are defined clearly.

Costs involved in the operation of a process facility fall under two main headings, as follows:

- Production costs
  - Labor
  - Materials
  - Utilities and services
  - Maintenance and repairs
- Fixed charges
  - Interest on investment
  - Depreciation
  - Insurance
  - Property taxes

As the author points out, profits from an operation stem from savings in production costs. Production-cost savings from an alternate manufacturing method are inherent to the design of the improvement or change and are determined by the process employed. The fixed charges, on the other hand, are fixed by the investment and bear a percentage or mathematical relationship to it. They depend on the projected life of an installation as well as on the interest rate on money used to create the installation.

It is usually advisable to figure annual savings for the improvement by deducting fixed charges from the production-cost savings for the projected life of the installation. This procedure requires computation of the fixed charges from assumptions or data available on the useful life of the equipment, property taxes, insurance, and the interest rate at which the company can borrow money. It is to be noted that the annual savings obtained in this case are for a specific period during which the cost and retirement of the investment are provided for.

It is also helpful when considering a new investment or an extra investment as between alternatives to divide the investment by the annual production-cost savings to determine how quickly the proposed improvement could pay for itself if all savings, derived from the design of the improvement, were used in retiring the investment. This ratio is an approximate rule of thumb and, as such, avoids consideration of depreciation and other fixed charges pertaining to the investment.

One answer is given in the form of dollars of savings per year for so many years whereas the other gives a pay-off period of so many years. Each has a sphere of importance depending on the type of improvement and the type of business involved.

In certain types of business the profits or savings are dependent on variables far removed from the life expectancy of the proposed improvement or the method selected for retiring the investment. Such things as product style and popularity, sales, advertising, and market conditions directly determine the volume of goods sold and resulting profits. In this type of industry, a particular process may become obsolete in a comparatively short time even though component parts and equipment are modern and suitable for other applications. It is also true that in this type of industry competition is more highly advanced, making it necessary for management to develop volume production for the process improvement or new product rapidly before others undertake it. Management therefore cannot be wholly governed by orthodox methods of computing annual savings based on the expected life of the equipment. In these instances, the pay-off period provides an indication of the time required to replace the investment from production savings. This figure can be compared with the projected period for volume business so that expected savings or gross profits from the process improvement can be calculated roughly. Efficient management in a particular business can determine roughly the period for volume business from its experience and knowledge of business conditions. In most instances this is beyond the scope of work for the engineer-estimator who performs, as his part, the important service of portraying accurately the amount of investment and the production-cost savings involved.

Many companies have an established policy in regard to the period in which the equipment must pay for itself. Such periods are based on the experience of a number of installations and have no relationship to the life of the equipment or the accounting method used for amortizing investments.

The following reference is made to L. P. Alford's handbook[3] containing information from a survey by manufacturing industries:

"Of 39 companies having fixed times in which equipment must pay for itself, twelve used 2 years, six used 3 years, eight used 5 years, one used $7^1/_2$ years and the weighted average was 3 years."

"Answers to Manufacturing Industries questionnaire indicated that even those companies that expected new equipment to pay for itself in 1, 2, or 3 years in general charged the cost of such equipment to capital account and then depreciated it in the regular way at rates used for that particular type of machine."

At the other extreme there are businesses which are steady from year to year, and are affected by competition and consumer acceptance to a lesser degree. Such businesses will improve their products and process operation from time to time following more general trends of development and opportunity. Obsolescence in such cases is of less importance and can be allowed for in long-term commitments. The electric-power and heavy-equipment industries are typical of this second group.

[1] Engineering Manager, Day & Zimmermann, Inc., Philadelphia, Pa. Mem. ASME.

[2] "The Return on Investment," by H. J. Lang, Mechanical Engineering, vol. 72, November, 1950, pp. 890–894.

[3] "Cost and Production Handbook," by L. P. Alford, Ronald Press Company, New York, N. Y., 1940, pp. 774 and 775.

Several formulas have been devised for use in determining the economies of manufacturing-equipment replacements. The formulas of the Materials Handling Division of the Society[4] are examples of this. In most cases the answer is expressed in terms of annual savings or profit on the additional investment.

It is the opinion of the writer that pay-off periods based on production-cost savings are of interest and value to management in all types of industry, but especially to those manufacturing products in newly developed or highly competitive fields.

There is no question that Federal income taxes have a bearing on net profits to be obtained during the life of a process facility, but these taxes depend on a company's composite operation. Also, there is no assurance that a company will produce a taxable profit for any given year or that the Government, at some unfortunate point in the future, may not set up a sliding scale of income taxes which would further complicate investment-return estimating. There are, in addition to Federal income taxes, other demands on business which enter into the over-all accounting procedure. For the engineer-estimator to be familiar with the complete corporate tax and financial-policy picture would be asking too much for an individual trained in other lines. The writer therefore is of the opinion that the income tax should be left out of calculations for pay-off period and annual savings, prepared by members of engineering departments, and that these should be considered only by management setting the over-all policy.

The paper appropriately mentions that there are intangible elements in cost studies which must be considered carefully before decisions are reached. Such items as the water shortage (specifically mentioned), working conditions, improved quality, public relations, and many other intangible elements, often have values greater than direct costs or possible savings. Some of these elements the engineer-estimator can evaluate quite accurately; others require consideration by specialists in specific business fields. Decisions on projects involving sizable investments, therefore, require group attention with final decision by persons in charge of management policies.

COMMENT BY ARTHUR LESSER, JR.[5]

The author's chief contribution in this paper is the translating of pay-off periods into yields or rates of return on investment. He recognizes that there is little difference in making comparisons by using the pay-off period or percentage yield but he believes that the yield figures which can be compared with yields on securities of various types are more easily understood by those responsible for raising the money required for investments.

The real question is whether an accurate and meaningful comparison can be made between the yields on securities or other investments and the yields on capital equipment over the service life of the equipment. The author evidently believes that such a comparison can be made usefully and accurately. The writer, however, thinks that an accurate comparison is possible only under very special conditions. Some examples will make this point clear.

When purchasing a bond, the buyer purchases a rigorously defined set of future expectations, usually in the form of specified semiannual coupons as a rental fee for the money, plus the full sum at the end of the life of the bond. Thus the yield to maturity has a specific meaning to the buyer, especially for short-term bonds or notes. With more distant maturities, such questions as callability, financial soundness of the concern, length of time the bond is held by the buyer, and other factors frequently make the yield to maturity more academic than real to all but the large institutional buyers. Other cases that come to mind where yields to maturity are meaningful are long-term leases on property, and long-term mortgages which are amortized over the life of the mortgage. As examples in the capital-equipment field, let us examine the two mentioned by the author.

The first example is the water-supply problem with the first alternative possessing no cooling tower, and the second alternative with one. The yearly expenses for the first alternative are $9000, because of the need to purchase all the water, and for the second alternative are $6000. Do these expenses remain constant or reasonably constant over the 10-year period? Is obsolescence an important factor? Obsolescence adds an uncertainty factor similar to the callable feature of bonds; however, the latter is easier to compensate for in computations.

From the physical point of view, do the facilities offer equally unimpaired service throughout their useful lives? The second example deals with the additional new capacity costing $1,000,000. The same type of questions can be asked in this case.

As to the answers, the writer would imagine that the expenses in example 1 of the two alternatives may remain fairly constant over the 10-year period, although the cost of water may go up. Most likely, maintenance and repairs on the water tower will increase with age, and probably the efficiency will decrease slightly. However, in example 2, who would want to forecast over a period of 10 years the net profits on sales even with past records available? Certainly the forecast of yield on the additional investment based on the first year's forecast, which may be quite accurate, is not adequate. With the yearly net profits fluctuating, perhaps widely and without regard to forecast, and with the unknown factor of obsolescence, how can this yield on investment be compared satisfactorily with the yield on securities where the payments are much more certain? In between examples 1 and 2 given by the author, may be capital equipment in manufacturing. However, here too a dynamic economy and rapidly changing technology necessarily make forecasts very inaccurate.

The writer, therefore, concludes (1) that although the mathematical treatment is the same, comparability of yields on securities and capital equipment is good only in special cases where constancy can more or less be depended upon, such as, possibly, in example 1; and (2) that comparability is likely to become worse and worse as the time period increases. It should not be forgotten that the table was constructed from the ordinary annuity certain, not uncertain. It might be argued, as the writer suggests, that the yield to maturity on some long-term bonds turns out to be academic also. Although this is true, the uncertainties involved are functions of entirely different variables and hence comparing them mathematically is not likely to be fruitful.

The author's table of yields may be helpful for the purpose of determining yields against some norm as to whether equipment should be replaced or not by new equipment—a common problem. However, the whole concept of determining whether to replace or not to replace based on a percentage return on investment due to savings has been vigorously attacked by George Terborgh.[6] One of the telling points Terbough makes is that the older and more obsolete is the equipment to be replaced, the larger becomes the annual savings and hence the rate of return, or yield. It follows, therefore, that the longer replacement is postponed,

[4] "Formulas for Computing the Economies of Laborsaving Equipment," by J. A. Shepard and G. E. Hagemann, Trans. ASME, vol. 47, 1925, pp. 525-551.

[5] Associate Professor and Chairman, Economics of Engineering Department, Stevens Institute of Technology, Hoboken, N. J.

[6] "Dynamic Equipment Policy," by George Terborgh, McGraw-Hill Book Company, Inc., New York, N. Y., 1949.

the greater the rate of return on the new investment appears to be. This obviously leads to an absurd result. This observation is made merely to point out that even should the yield from capital investment be considered comparable to the yield on securities for practical purposes, it is questionable as to how valuable the concept is as an aid to managerial decision making.

In general, the author has made a clear and concise presentation of his topic. He points up the need of stating the assumptions used in tackling the problems. He is well aware of the impact of the income tax on deciding among alternatives. He does not miss the importance of intangible factors nor of maintaining liquidity. However, he does advocate not charging interest as an expense if no actual payment is made.

Most writers will disagree with this contention arguing the opportunity foregone principle. The accountant will agree with the author and so will the economist, but will the businessman agree or will he set a higher percentage of return, however computed, in making a decision between alternatives to compensate for his failure to charge interest? The author has not satisfied the writer that the viewpoint in this respect is sound.

Finally, he suggests that land, because it may lose value, should be considered a depreciable asset. Although one cannot deny that the use value of land, as differentiated from physical land itself, may depreciate over the years, he gives no ideas as to determining the depreciation rate. Therefore, how does one go about treating land as a depreciable asset?

Furthermore, the writer sees no point in so treating land, if it is done with the idea the business may close down and sell its land at an indeterminate future date. All other assumptions, when buying capital equipment, are based on the going concern. No computations of yield or anything else would have meaning if we must reckon with the possibility of closing the business and selling the assets, usually at prices well below the use value to the business as a going concern.

Comment by V. A. Lim[7]

The disposition of hidden costs in cost studies is one that is difficult to comprehend for one not well grounded in accounting and financing concepts. The author states that the undepreciated balance of the valuation of a piece of equipment should not influence cost studies pertaining to its replacement. His main argument is that the money disbursed to purchase this equipment has already been spent, and, therefore, no longer pertinent to the discussion.

However, it must be recognized that the retirement of the equipment before it has served its estimated life removes its ability to pay for itself in the form of depreciation charges against its output. It seems logical that these depreciation charges should, therefore, be loaded on the replacement, instead of written off as a capital loss. Handled in this manner and introduced into the cost study as some form of depreciation or amortization charge, it will certainly exert some influence on the final outcome of the computation.

Carrying the author's problem of the new plant capacity further, and assuming that this new plant capacity is to replace an old plant, an addition of $120,000 to net profits per year seems to be indicated. Now, suppose that the undepreciated balance of the plant to be replaced is about $1,000,000. Neglecting this figure, it would appear as if a replacement is strongly recommended profitwise, when in reality, it would be only about $20,000 that will be saved annually. Granting that the foregoing sample may be an extreme and rare case, nevertheless it will be seen that neglecting the remaining amortization of the plant to be replaced neglects an item of expense that can be critical.

An interesting sidelight on the use of yield figures is its comparison with a desirable standard. The choice of this standard is obviously dictated by the financial condition of the company and the temperament of its management.

One useful criterion of yield for cost studies is the ratio of the company's profits divided by its net worth (capital items plus surplus) before or after taxes, depending on how the initial yield was computed. The theory behind this method is that the company should endeavor to invest money for return rates at least equal to that currently obtained by company operations, based on the investment of stockholders, original plus undistributed and accumulated profits.

Author's Closure

The author cannot agree with Mr. Hopper that the pay-off period ratio is "an approximate rule of thumb and, as as such, avoids consideration of depreciation and other fixed charges pertaining to the investment." Depreciation, of course, cannot be considered, or the ratio has no meaning. But differences in property taxes, insurance, and interest payments among the alternatives being considered must be included with production expenses, or the pay-off period will be fictitious.

Mr. Hopper also states that income-tax calculations should be left out of economy studies prepared by engineers. The author believes that this overestimates the complexity of allowing for income taxes. Taxes are, after all, disbursements, and, if these disbursements grow and grow, as they have been, they cannot be neglected. An excellent coverage of the subject for the engineer-estimator has been made by Eugene L. Grant.[8]

To Professor Lesser, the author would like to reply that his paper would have taken an entirely different slant if he had read Terborgh's "Dynamic Equipment Policy,"[6] before rather than after the paper was prepared. He is right in saying that the chief contribution is translating pay-off periods into yields, or rates of return on investment.

Professor Lesser questions the advisability of comparing yields for investments in new plant, which are relatively uncertain, with those for securities, which are relatively certain. The only point of the comparison is that investments which are uncertain should show much larger returns than investments which are certain.

With regard to the opportunity-foregone principle, in making an economy study it is important to state the alternatives. Would a business invest in securities if it did not invest in plant and equipment? If these are the alternatives, yields on securities obviously enter the study. If the alternatives are to distribute profits to stockholders, or to invest in plant and equipment, then interest is not a factor.

To Mr. Lim, the author can only reply that depreciation on existing assets, since it is not an out-of-pocket expense, is not an element in the type of economy studies he has in mind. Perhaps a book on economy studies (one of the best is the book by Eugene L. Grant,[8]) will convince him of this.

H. J. Lang.[9]

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[7] Assistant to President, Mindanao Mother Lode Mines, Inc., Manila, P. I. Jun. ASME.

[8] "Principles of Engineering Economy," by E. L. Grant, third edition, The Ronald Press Company, New York, N. Y., chapter 17, 1950.

[9] Senior Process Engineer, C. F. Braun & Co., Alhambra, California. Jun. ASME.

Glass as a Coating for Steel

Comment by E. W. Neben[10]

This paper[11] is a definite step forward in calling the attention of those not familiar with glass-lined steel to its possibilities as a material of construction for the process industries.

In addition to the examples cited in the paper, there are uses in the chemical-process industries for which various manufacturers have developed standard units in glass-lined steel.

Reactors of this material combination were instrumental in the success of the synthetic-rubber program where they were used for polymerization work. The smooth glassy surface was determined to be the most economical solution to the surface-sticking problem inherent in this reaction.

In the manufacture of synthetic detergents, glass-lined steel is used for the sulphonators because of the excellent corrosion resistance of the glass in acid service, and the impossibility of picking up iron which would degrade the final product.

Because of its resistance to chlorine and HCl, glass-lined steel is used extensively in operations where these chemicals are encountered.

It should be brought to the attention of those concerned with problems of material selection for the process industries that glass-lined steel, in many instances, can be the best and also most economical solution.

Comment by G. H. Spencer-Strong[12]

The author has described ably three widely different functional uses of glass coatings for steel. The examples discussed are well chosen, since they demonstrate the widespread functional uses of the product, as well as three applications which require widely different approaches for their ultimate solution. He probably has been unduly modest in discussing the problems encountered and the ingenuity required for their successful solution.

As a result of long and successful experience, it is often taken for granted that glass, or so-called porcelain-enamel coatings, applied to metal provides a superior corrosion-resistant type of coating. The public at large, however, for centuries has considered enamels as a decorative finish, since this is the historical usage of the material. The highly decorative appearance of modern domestic appliances, sanitary ware, and porcelain enamel architectural products has possibly helped to enhance the idea, even though in all of these uses corrosion resistance is at least equally as important as decoration. For functional usage, corrosion resistance, is, of course, paramount.

The successful application of glassy coatings to functional parts often requires considerable ingenuity, both from the standpoint of the actual application and maturing of the coating and the design of the parts in question. The author touches briefly upon these phases of the operation when he describes the special furnaces and furnace-atmosphere controls which his company has found to be necessary for the proper firing of its products. Obviously, the application and maturing of a glassy coating on a tank 11 ft in diameter and 42 ft long is not a simple operation but one which requires much thought, experience, and ingenuity. Similar problems arise with much smaller pieces. An example in point is concerned with the coating of water-meter covers. In one metropolitan area, water meters normally are installed underground on the outside of the premises in question. In order to protect the meters, cast-iron covers have been found quite satisfactory. Unfortunately, electrolysis, set up as a result of the grounding of appliances, and the like, makes the service life of the covers extremely short. It was felt, therefore, that the application of a porcelain enamel, or glass coating, to the covers would greatly prolong their service life. In first consideration, this problem appears very simple, since the only two requirements for such covers are complete continuity of coating and a sufficiently tight fit to prevent leakage, the proper fit being obtained by machining. Initial experiments with the application of glassy coatings failed owing to growth and warpage of the castings in the enameling operation. The enameler in question fortunately had a great deal of experience with this type of work and was able to solve the problem quite simply by annealing the castings prior to the machining operation. As a result, there was no further distortion, and it was possible to apply the enamel and grind it flat over the machined areas, thereby providing a satisfactory fit. The subsequent product fully lived up to anticipation as regards prolonged service life.

The factor of design, of necessity, has been considered only briefly by the author; however, it may be well to point out that proper design is one of the basic requirements of the satisfactory application of porcelain-enamel coatings to industrial uses. It is necessary that all exposed surfaces be coated completely if adequate protecton is to be given. Unfortunately, at the same time, it is necessary to introduce the parts into a furnace in order to fuse the coating. Many attempted uses of porcelain enamel have failed because of the fact that the designers overlooked this basic requirement which, undoubtedly, could have been overcome in most cases by some rather simple changes. That the problem can be overcome without undue difficulty has been shown by the author in his discussion of the application of glass coatings to the domestic hot-water tank and the "Harvestore."

Another interesting point as regards design is the fact that each of the three examples cited involves a different method of fabrication and assembly.

Author's Closure

The author is indebted to Mr. Neben and to Dr. Spencer-Strong for their kindly remarks on our effort to present a rather broad subject briefly. Their comments have been exceedingly well chosen to add important information and to emphasize certain points which are basic to the general subject.

W. G. Martin.[13]

Grinding Fluids

Comment by W. H. Oldacre[14]

This paper[15] gives us the benefit of a comprehensive research covering a difficult subject. Precision grinding has made significant and important advances in the last decade, and there is great need for additional work of the type reported by the author.

It is futile to disagree with such well-documented data without supporting evidence, but the writer would like to question two of the author's conclusions.

"Grinding oils provide maximum lubrication, and water (alone or with compound) maximum cooling." This rather broad generalization neglects the

[10] Process Engineer, The Pfaudler Company, Rochester, N. Y. Jun. ASME.

[11] "Glass as a Coating for Steel," by W. G. Martin, Mechanical Engineering, vol. 73, February, 1951, pp. 109–113.

[12] Research Laboratories, Pemco Corporation, Baltimore, Md.

[13] Manager Glass-Coating Materials Division, A. O. Smith Corporation, Milwaukee, Wis.

[14] President and General Manager, D. A. Stuart Oil Company, Ltd., Chicago, Ill. Mem. ASME.

[15] "Grinding Fluids—Characteristics and Applications," by H. W. Wagner, Mechanical Engineering, vol. 73, February, 1951, pp. 128–132.

fact that, above the boiling point of water, oil is a better coolant than water containing soaps or similar compounds.

"Oils are most costly. . . ." Considering the fact that oils are usually reclaimed while water-mixed compounds are not, the difference in final cost is greatly reduced and sometimes eliminated.

COMMENT by J. T. BEARD, Jr.[16]

This paper on "Grinding Fluids—Characteristics and Applications" presents the results of an extensive research program, and Mr. Wagner and his associates in the Norton Company are to be congratulated on their contribution to the art of grinding metals. Most interesting is the relatively new concept that "attritious wear" (dulling of the abrasive grains) depends not only on the hardness of the grains with respect to the metals that are ground, but also on their solubility in those metals. This would explain why silicon carbide, although harder than aluminum oxide, dulls more rapidly when grinding hard steel. I have the following additional comments to offer:

In Table 3, page 129, kerosene and straight mineral oil are given the same high rating as lubricants—lubricity being defined as that property of grinding fluid that enables it to prevent severe wheel loading, and at the same time, retard dulling of the abrasive grains. I think most of our field engineers would agree that the presence of kerosene in a soluble-oil emulsion is helpful in preventing loading. To that extent it keeps a wheel from the kind of dulling that results from loading. But does kerosene keep the grains of a relatively clean wheel from premature dulling? If not, then can we say that its lubricating value in grinding is high?

The writer quite agrees that, in preventing rust and in providing better lubrication, a richer and more costly mixture of a water-soluble oil may be desirable, as long as it does not lead to foaming or to gum-loading of a wheel. However, it might be well to mention a third hazard, namely, that a very rich emulsion of a soluble oil may invert from an oil-in-water type to a slimy water-in-oil type that would be useless as a grinding coolant.

In Table 4, page 131, the greater effectiveness of high-pressure-jet application, as compared with low-velocity flow, is confirmed by field experience. For example, in thread-grinding with a good thread-grinding oil, the sharpness and contour of the wheel are better preserved when two high-pressure jets—one on each side of the wheel—are directed into the contact areas between the wheel and the work. With this arrangement, it seems that centrifugal force and windage are less able to keep the grinding oil from reaching the critical spots where the grinding is being done.

[16] Lubricating Department, Socony-Vacuum Oil Company, Inc., New York, N. Y.

AUTHOR'S CLOSURE

The kind comments, additional information provided, and the questions raised are all highly appreciated.

Mr. Oldacre's exceptions to two general conclusions are well taken. Presumably, he is thinking of a steam blanket which can be formed between the work and liquid water to make a thermal insulation, when he says that "oil is a better coolant than water" under certain conditions. It is the author's opinion that such steam blanket makes water inferior to oil as a coolant only in rare cases in grinding. Equal replacement costs, as between grinding oil and water-mixed compounds, can be visualized when thorough reclamation of the oil is practiced.

Mr. Beard questions the equally high rating of kerosene with straight mineral oil for lubrication. The ratings had been made having in mind the effects of those two fluids (relative to water) in their respective fields. In heavy grinding of steel, kerosene would be inferior to a mineral oil of higher viscosity. In slicing quartz, kerosene would be expected to be more suitable than the heavier mineral oil. Fig. 3 of the paper exemplifies the effect of kerosene in keeping the abrasive grains of the wheel free from premature dulling.

Mr. Beard points out the danger of inversion of an overly rich emulsion. This warning is worth keeping in mind. Confirmation of the benefit of high-velocity jets is gratifying.

H. W. WAGNER.[17]

Planning Your Future

COMMENT BY ERCOLE ROSA, JR.[18]

The author[19] gives some very sound advice for the young engineer about to plan his future. The approach suggested in this paper will do much to reduce the uncertainties in the path of the young engineer.

The problems discussed by the author should also be of interest to the experienced and established engineers, because it is they who will play a large part in the development of the new generations of engineers. Because of their experience and understanding of engineering opportunities, these engineers are in the position to give useful guidance to the young engineers.

There would seem to be several other bits of advice that can be given to the young engineer who is in the process of planning his future.

By the time the young engineer is about to graduate he has pretty well determined what type of work he wishes to do by the nature of the studies that he has taken while in school. By then, the problem generally reduces itself to one of selecting the company in which he would prefer to be employed. Selection of the company to join may be a primary decision affecting the future of the engineer.

The company should be selected on the basis of consideration of these factors:

1 Economic-growth possibilities of the company and of the industry.

2 Relative position of the company within the industry.

3 Reputation and achievement of the company.

4 Reputation and achievement of the individuals within the company.

5 Advancement possibilities within the company.

The young engineer should not be influenced by whether or not the particular company of his choice is publicly hiring engineers. If he has prepared a sound evaluation of the company and it has created within him an enthusiasm for that particular company, then it should not be difficult for him to convey this enthusiasm to the individual in the company responsible for the selection of new engineers.

One last point which should be emphasized here is related to the decision confronting the young engineer who finds that his present position does not offer sufficient opportunities for development. The young engineer must be prepared to make the change if he finds that his development is being hindered. Sometimes this change is difficult to make, involving as it does the leaving of an established position for one that is new. It may require courage, but the benefits may be numerous. There are many engineers who have found new opportunities by simply changing their positions.

[17] Research and Development Department, Mechanical Section, Norton Company, Worcester, Mass.

[18] Instructor, Department of Industrial Engineering, Columbia University, New York, N. Y. Jun. ASME.

[19] "Planning Your Future," by T. A. Marshall, Jr., MECHANICAL ENGINEERING, vol. 73, March, 1951, pp. 216–218.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Kent's Mechanical Engineers' Handbook

KENT'S MECHANICAL ENGINEERS' HANDBOOK. (Wiley Engineering Handbook Series.) Vol. 1. Design and Production Volume, edited by C. Carmichael. Vol. 2. Power Volume, edited by J. K. Salisbury. John Wiley & Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England. Twelfth edition, paged in sections, 1950. Leather, $5^1/_2 \times 8^1/_2$ in., illus., diagrams, charts, tables, bibliographies, $8.50 each volume.

Design and Production—Volume 1

REVIEWED BY E. L. MIDGETTE[1]

THERE are numerous books containing detailed information about the design of particular component parts of mechanisms and machines. There is in published periodicals an almost unlimited number of papers, research tracts, and discussions of the problems in design of specialized components and equipment. Books and papers on engineering materials are plentiful. Discussions of both general and specialized production processes and problems are also plentiful. The digestion and rendering of this mass of information and data in ready-reference form has been the purpose of handbook editors and publishers for years. This handbook has through 11 earlier editions developed and enjoyed an enviable position in this field. In the Design and Production Volume of the most recent, or twelfth edition of this handbook series, this earlier prestige is being much further enhanced.

Since by nature the material in a handbook has to be concise in statement while at the same time comprehensive in coverage, the problems of writing for such a publication are numerous. The subjects that must be covered include an extremely wide variety of materials. It is to be expected that material to go in one section may be so closely related to material in another section as to practically demand inclusion in that section also. Therefore, the work of the editor of such a handbook is very exacting. It is up to the editor to so order and arrange the material that duplication is avoided without detracting from the picture presented by each of the sections. In order to accomplish this it is necessary that the editor have an extremely well informed over-all view of the problem and have a well formulated idea of the direction and emphasis the material should present.

Colin Carmichael, editor of the twelfth edition of the Design and Production Volume of Kent's Handbook, has proved himself extremely capable in carrying out these functions of the editor. The book reads smoothly while being packed with a storehouse of specific data and information in precise statement and ready reference form. Emphasis, as indicated by the title "Design and Production," has been toward pointing up the oneness of the problem of engineering design and manufacturing. The problems from the design and layout of the equipment through the selection of materials, and the establishment of the production procedure are closely related and considered as different aspects of the one job, the economical production of engineering equipment. The work of 92 individuals, possessing specialized knowledge of particular aspects of the over-all problem, has been put together by the editor to make this volume. The material has been grouped in 28 major sections. However, these sections fit together to present information on essentially four major divisions of the over-all problem. Sections 1 to 6 have to do with the selection of materials. Sections 7, 8, and 9 have to do with basic design principles. Sections 10 to 18 form a work on the design and selection of machine components. Available production processes and production plant equipment are discussed in sections 19 to 27. The volume is rounded out by the inclusion in section 28 of mathematical tables. The text material in this twelfth edition has been almost completely rewritten in order to insure the inclusion of the latest and best information available on any given subject. A further important part of the volume is the inclusion at the end of each subject of a large bibliography covering related source material. These bibliographies alone will prove well worth the cost of the volume to the practicing engineer. The resulting book is a major addition to the reference library of the mechanical engineer and will stand as a major credit to the authors, editor, and publisher who co-operated to make it possible.

[1] Professor, head of Mechanical-Engineering Department, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Mem. ASME.

Power—Volume 2

REVIEWED BY W. A. SHOUDY[2]

FOR only 55 years have mechanical engineers had available a convenient reference book. Before that time each one collected his own data and its later availability depended on one's skill in filing, but principally on one's memory. The budding engineer did not know what material to save and filed nothing or accumulated so much that his wife rebelled. William Kent had a 20 year accumulation which he condensed by four years of hard work and published as his "Pocket Book"—and it was a pocket book, this reviewer has carried the first edition in his overcoat pocket.

We had Trautwein for civil engineering and handbooks like Haslam and Tulley and others, all of which were more like our condensed textbooks for the "practical" man. Only in our college textbooks could we renew our knowledge of the fundamentals. Anyone who studied Rankine knows that his could not be called pocket books.

Kent's Pocket Book became so popular

[2] Executive Manager, Cooling Tower Institute, Basking Ridge, N. J. Fellow ASME.

that he was soon revising it with added material, a better index, and correction of errors, some unfortunate. William and his son, Robert Thurston Kent, edited 11 editions but when William died in 1918, it was realized that the profession had expanded so broadly that no one man had sufficient experience to write a handbook and a staff of experts were selected by Robert who served as editor.

When Robert died in 1947, it was no longer a pocket book, but had grown to two 6 × 9 in. volumes of about a thousand pages each. The first pocket book was chiefly a collection of tables with little comment on their use. Possibly a mistake was made in the first two-volume edition by making it too much like two volumes of condensed textbooks. A handbook must include all essential information that is not common knowledge—and sometimes refresher courses—but the abundance of material requires the most careful pruning.

The twelfth edition is now available and is the first with which Mr. Kent's family has not been identified. The editors are new and young, without precedents, and with few prejudices. The handbook is new and they have done a good job.

This review is concerned with only the volume on power, which has been edited by J. Kenneth Salisbury of the General Electric Company and a staff of 80 authorities. This one volume is larger than the last single volume of which power was only a part. Thus has the profession grown.

Although our colleges of technology have kept abreast with engineering developments, they are no longer the only source of authoritative information. There are only 13 professors listed among the 80 authorities. Within this reviewer's field, Professor Christie's section on steam turbines stands out as the best textbook on this subject thus far published. Professor Trink's condensation of steam-engine theory and performance should be of great value to engineers of this generation to whom the colleges have said there still are steam engines, but have taught little else. Professors Mackey, Bailey, and Kayan have compressed the incompressible thermodynamics into a welcome reference section.

The art and techniques of engineering, and some fundamentals, must come from the manufacturers and a few consultants, both have been generous in making available to the editor, information that formerly was considered "trade secrets." This is a wise attitude for though "a little knowledge is a dangerous thing" no knowledge is worse. Unless the customer knows somewhat of the manufacturers' problems he often asks for the impractical, but with such knowledge he can often find new applications for the equipment beyond the viewpoint of the manufacturer.

One difficulty resulting from the selection of authorities from the manufacturers' staffs is that each, being human, tends to forget that his competitors sometimes also offer good equipment. Professor Christie remembers that others beside the General Electric Company manufacture steam turbines, but there seem to be no condenser manufacturers other than the Foster Wheeler Corporation.

This reviewer has been under the impression that The Babcock & Wilcox Company, Riley Stoker Corporation, and Foster Wheeler Corporation, and others also make boilers, but he has found no reference to them. The handbook is not intended to be a buyer's guide, but the readers' confidence in an otherwise excellent section on steam-generating units is somewhat lessened on noting that the illustrations for each chapter are confined to those of one manufacturer, but this editorial error does not outweigh the reputation of the contributing authorities.

It is obviously impossible for one man to make a critical review of such a handbook, he can only "spot check." This the reviewer has done by looking for the information that he has needed in the past and he has found it and some not expected. He has also learned something about gas turbines, panel heating, and even atomic power.

The book is up to date, authoritative, well edited, and useful.

Transfer of Heat and Mass

INTRODUCTION TO THE TRANSFER OF HEAT AND MASS: With an Appendix on Property Values by Robert M. Drake, Jr. By E. R. G. Eckert. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 1950. Cloth, $5^3/_4$ × 9 in., 143 figs., 18 tables, plate, index, xiii and 284 pp., $4.

REVIEWED BY MAX JAKOB[3]

BEFORE and during the time when Hitler was in power, Dr. Ernst Eckert was one of Germany's best experts in heat transfer and related fields. Now this country enjoys the benefits of his productive work. This book is said to be a new edition of a German book which was written to introduce students to the transfer of heat and mass. However, its level is higher than usual in introductory books.

The main layout of the book is clear and simple. In five chapters the following five items are treated: Fundamental principles, conduction, convection, radiation, and mass exchange. These chapters are different in length, 134 pages dealing with convection, 40 with conduction, and only 30 with mass exchange which in the title of the book is coordinated with heat transfer. Moreover, about 12 of these 30 pages are devoted to the thermodynamics of humid air rather than to mass exchange.

The title, "Fundamental principles," of the first chapter is not well justified. This chapter contains only some elementary items on heat transfer. The second chapter is also rather elementary, the less elementary parts (unsteady heat conduction) being more of a descriptive than of an analytical character.

It is different with the following chapters. The chapter on convection contains a thorough analytical treatment of the boundary-layer concept and, in particular, a simplified application of the momentum principle to the boundary layer as first used, thirty years ago, by Th. von Kármán to whom the author gives full credit. The behavior of the boundary layer regarding the heat transfer is illustrated by some interference photographs which were taken by the author in co-operation with E. Soehngen. Dimensional analysis is discussed in an original way.

It is, however, regrettable that the author does not follow the well-founded recommendations of the American Standards Association regarding the symbols for dimensionless groups. A short section is devoted to heat transfer in gases at high velocities, a field in which Eckert and Drewitz made a valuable contribution. By the way, it is not nice of Eckert, when quoting the famous equation of Barré de Saint-Venant, to deprive this man of nobility and sanctity by calling him D. S. Venant. In general, this chapter gives a clear synopsis of what is known at present about heat convection.

The chapter on radiation again includes results of Eckert's own research, for instance, curves showing the distribution of the emissivity of materials in different directions according to E. Schmidt and Eckert and charts of the emissivity of carbon dioxide and water

[3] Research Professor of Mechanical Engineering, Illinois Institute of Technology, Chicago, Ill. Mem. ASME.

vapor, also from his and Schmidt's studies.

In the chapter on mass transfer a modification of the momentum method is used. The procedure becomes rather involved and, in addition, the somewhat questionable simplification is made that the difference in the molecular weights of gases diffusing through each other is negligible. The writer finds E. Schmidt's and W. Nusselt's similarity methods easier to follow.

The book does not contain any problems to be solved by the student, but a number of examples illustrating the procedure in calculations.

The appendix, prepared by R. M. Drake, is devoted to the pertinent properties of various substances. For water and water vapor, instructive charts of a wide range of temperatures and pressures are given. They are based upon different sources and should be used with some caution because reliable experimental data are still missing in quite some ranges covered by these charts. The tables for metals, liquids, and gases at different temperatures seem to be well chosen and are presented in a systematical form.

A great number of minor inexact statements and printing errors impair the beauty, but not the intrinsic value, of this book.

Heat Engines

LE MACCHINE TERMICHE. By Mario Medici. C.E.D.A.M., Padova, Italy, fourth edition, 1950. Cardboard, $6^1/_2 \times 9^1/_2$ in., illus., diagrams, charts, tables, 947 pp., L.It. 6000.

This book is a comprehensive treatise on heat engines, with sections on turboblowers, compressors, and heat pumps. Theory is adequately treated, while the descriptive and illustrative material is excellent, varied, and extremely modern. The many detailed calculations given as examples are a praiseworthy feature of this book. Steam power is comprehensively treated, including all phases of steam generation, combustion, control, power generation in turbines and piston engines, condensers, and auxiliaries. Internal-combustion engines of all types are discussed, described, and illustrated; there are nearly sixty pages on industrial gas turbines, while an appendix deals with atomic-power generation. The fact that the descriptive and illustrative material and the calculation examples refer to recent U. S., British, and Continental practice renders this volume particularly interesting for American readers.—P. F. MARTINUZZI.

Books Received in Library

ARTIFICIAL FIBRES. By R. W. Moncrieff. John Wiley & Sons, Inc., New York, N. Y., 1950. Linen, $5^1/_2 \times 9^1/_4$ in., 313 pp., illus., diagrams, charts, tables, \$4.50. This book presents pertinent material on "man-made" fibers. Of the five main divisions, the first deals with the structure and properties of fibers in general. In the second part, the history, chemical nature, manufacture, properties, dyeing, and uses of regenerated cellulosic and alginic fibers are discussed. Parts 3 and 4 treat in the same manner the regenerated protein fibers and synthetic fibers, respectively. In the last section, the processing of fibers is considered. Suggestions for further reading are given at the ends of the chapters.

COSTS, BUDGETING AND ECONOMICS OF INDUSTRIAL RESEARCH, Proceedings of the First Annual Conference on Industrial Research, June 1950, sponsored by the Department of Industrial Engineering, Columbia University. Edited by D. B. Hertz and A. H. Rubenstein. King's Crown Press, Columbia University, New York, N. Y., 1951. Paper, $5^1/_2 \times 8^1/_2$ in., 261 pp., diagrams, tables, \$4.50. This volume contains the abridged and edited proceedings of the first annual Conference on Industrial Research held at Columbia University in June, 1950. The theme of the Conference emphasized costs, budgeting, and economics but other aspects were also considered. In addition to the papers, summaries of the clinic-session discussions are also given. A short bibliography is included.

FORSCHUNGSHEFTE AUS DEM GEBIETE DES STAHLBAUES, Heft 7. Über den Einfluss hochfester Stähle auf Gewichtsersparnis und Bauart im Stahlbrückenbau, by O. Erdmann. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Paper, 8×11 in., 83 pp., diagrams, charts, tables, 10 Dm. Based on the author's experience, this book discusses in detail the theoretical considerations as well as the structural and design characteristics involved in the use of certain low-alloy high-strength steels for the construction of bridges. The various structural members and also construction methods such as welding, are considered. Numerous figures and tables illustrate the text.

HANDBUCH DER HOLZKONSERVIERUNG. By Mahlke and Troschel, edited by J. Liese. Third edition, Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Linen, $6^1/_4 \times 9^1/_4$ in., 571 pp., illus., diagrams, charts, tables, 52.50 Dm. This book covers the science and practice of wood preservation and protection. Written by specialists, the major sections deal with the characteristics of untreated wood, various damaging agents, protection of wood, examination of protecting substances (including standard testing procedures), and applications in which wood-protecting substances are used. A bibliography of international references is included.

JANE'S ALL THE WORLD'S AIRCRAFT 1950-1951, compiled and edited by L. Bridgman. McGraw-Hill Book Co., Inc., New York, N. Y. Linen, 8×13 in., 536 pp., illus., diagrams, tables, \$20. This standard handbook contains up-to-date and authoritative data on the civil and military aircraft of 62 nations. In this forty-first edition several new sections of information have been added, and hundreds of new illustrations. The section on military aviation is fully revised up to mid 1950 to include details on the recently organized air forces of Hungary, Israel, Indonesia, Lebanon, and the Philippine Republic. A new feature is a list of first flights made within the past year.

MECHANICS OF MATERIALS. By H. D. Conway. Prentice-Hall Inc., New York, N. Y., 1950. Linen, $6 \times 9^1/_4$ in., 325 pp., diagrams, charts, tables, \$6.35. This text, written as a first course, begins with a consideration of elementary stress and then compound stress and strain. Welded and riveted joints are then discussed, followed by the theory of torsion. The effects of shearing, bending, stresses, and deflection due to bending in beams are considered as well as clamped, continuous, and other types of beams. Columns are treated next, and their failure under combined stresses discussed. The last two chapters deal with thick shells under pressure and with statical indeterminancy.

METALWORKING LUBRICANTS, Their Selection, Application and Maintenance. By E. L. H. Bastian. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, $6^1/_4 \times 9^1/_4$ in., 357 pp., illus., diagrams, charts, tables, \$6. This book is a guide to lubricants and fluids used to secure more efficient operation in the working and processing of metals, as well as those used for forming nonmetals, such as plastics. It deals with the nature of metalworking lubricants, the properties affecting their performance in specific operations, their proper use in the plant, and the means of maintaining top efficiency of these lubricants under operating conditions. References are given at the ends of the chapters.

METHODS OF OPERATIONS RESEARCH. By P. M. Morse and G. E. Kimball. First edition revised, published jointly by the Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1951. Cloth, $8 \times 10^3/_4$ in., 158 pp., illus., diagrams, charts, tables, \$4. Of interest to industrial and merchandising executives, this book shows how the techniques of this applied science that were developed during the War can be used to help make decisions in many fields. It differs from the books on ordinary statistical analysis since it considers techniques which predict future operations in a concrete fashion. An explanation is given of the various "tools" used in this science and examples of successful applications to military problems are given. Detailed information is included for the establishment of an operations research group.

MODERN METHODS OF MATERIALS HANDLING. By the Material Handling Institute, Inc. Prentice-Hall Inc., New York, N. Y., 1951. Linen, $8 \times 11^1/_4$ in., 248 pp., illus., diagrams, charts, tables, \$5.50. The purpose of this book is to provide a broader basic knowledge for men in the materials-handling division of industry and to increase their on-the-job effectiveness. It describes a wide variety of methods and types of equipment which are in current use. After a discussion of general considerations, the special equipment and techniques for individual industries are treated in detail. Numerous photographs illustrate the text.

PERSONNEL HANDBOOK. Edited by J. F. Mee. Ronald Press Co., New York, N. Y., 1951. Fabrikoid, $4^3/_4 \times 7^1/_2$ in., 1167 pp., illus., diagrams, charts, tables, \$10. This handbook provides a comprehensive reference guide to the best practice in the field of personnel and industrial relations. It presents

guiding principles, factual data from experience, specific recommendations, criteria for evaluation, standards for comparison, step-by-step procedures, and case examples from practice. Specific practical problems which arise in the organization and implementation of training or safety programs, proper employee recruiting and selection, preparation for labor-contract negotiations and administration of contracts, testing, merit rating, etc., are also covered.

PHASE RULE AND HETEROGENEOUS EQUILIBRIUM. By J. E. Ricci. D. Van Nostrand Company, Inc., Toronto, Canada; New York, N. Y.; London, England, 1951. Fabrikoid, 6 × $9^1/_4$ in., 505 pp., diagrams, tables, $12. This book provides a systematic study of the meaning of the phase rule and its application to system of one to five components. Emphasis is placed on the interconnection between the familiar diagrams of systems of various orders with demonstration of the basic identities involved. Although concerned primarily with underlying principles, specific illustrations have been included of the more important and interesting relations.

PHYSICAL CONSTANTS OF HYDROCARBONS BOILING BELOW 350 F, prepared by ASTM Committee D-2 on Petroleum Products and Lubricants. (Special Technical Publication No. 109.) American Society for Testing Materials, Philadelphia, Pa., 1950. Paper, $8^1/_2$ × 11 in., 16 pp., tables, $1. Intended for testing engineers and others concerned with natural gasoline, synthetic rubber, industrial aromatics, and gaseous fuels, this pamphlet provides a compilation of tables covering a wide range of physical constants. References showing sources of the compiled information are listed in full.

PHYSICS OF POWDER METALLURGY, a Symposium held at Bayside, Long Island, N. Y., August 24–26, 1949, sponsored by the Metallurgical Laboratories, Sylvania Electric Products, Inc. Edited by W. E. Kingston. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × $9^1/_4$ in., 404 pp., illus., diagrams, charts, tables, $8.50. Presented at the Symposium on Powder Metallurgy sponsored by the Metallurgical Laboratories of the Sylvania Electric Products, Inc., the 22 papers in this volume provide an up-to-date guide on the theory and practice of powder metallurgy. Eight papers are contributions to the theory of sintering. Eight papers discuss basic mechanism in the field of the physics of metals. The remaining six present experimental data or reviews on practical problems of powder metallurgy. Each paper is followed by discussion, and most of the papers have lists of references.

PLANT LAYOUT PLANNING AND PRACTICE. By R. W. Mallick and A. T. Gaudreau. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1951. Linen, $6^1/_4$ × $9^3/_4$ in., 391 pp., illus., diagrams, charts, maps, tables, $7.50. Written for the administrative executive and plant engineer, this book is devoted to the principles and practice of planning, design, presentation, and economics of plant-layout projects. It covers both re-layouts and new plants with data on designing and evaluating all plant facilities and services. Plant location, building architecture, and construction engineering are not discussed. A bibliography divided into subjects covers both the topics covered and the three afore-mentioned topics which are not treated.

PRACTICE OF LUBRICATION. By T. C. Thomsen. Fourth edition revised. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 6 × $9^1/_4$ in., 617 pp., illus., diagrams, charts, tables, $8. This text provides a comprehensive coverage of the origin, nature, testing, selection, application, and use of all types of lubricants. New material presented in this fourth edition includes additives, the lubrication of aero engines and aircraft accessories, the use of fabric bearings in steel mills and the use of other types of bearings, synthetic oils, new solvent-refining processes, and developments in lubricant manufacture.

QUALITY CONTROL: Principles, Practice, and Administration. By A. V. Feigenbaum. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Linen, 6 × $9^1/_4$ in., 443 pp., illus., diagrams, charts, tables, $7. This book presents quality control as a business method for actual plant application. In four parts: The first discusses, from a general management standpoint, the nature and potential uses of quality control, activities, organization, and results; the second covers the statistical tools required; the third considers the application of quality control in engineering, purchasing, incoming inspection, manufacturing, sales, and so on; and the fourth develops the procedures for actually instituting a practical program.

SOLIDIFICATION OF CASTINGS, a Review of the Literature. (Monograph and Report Series No. 7.) By R. W. Ruddle. Institute of Metals, London, S.W. 1, 1950. Linen, $5^1/_2$ × $8^3/_4$ in., 116 pp., charts, tables, $2. Originally published as confidential reports of the British Non-Ferrous Metals Research Association, the book reviews the literature on the production of sound castings. Part 1 deals with studies on methods of gating and feeding in which no attempt is made to measure or analyze the actual progress of freezing in the casting. Part 2 reviews the more fundamental work which includes the measurement of rate of heat abstraction and rates of solidification. The work described in Part 2 and conclusions drawn therefrom are briefly summarized in Part 3.

SOURCEBOOK ON ATOMIC ENERGY. By S. Glasstone. D. Van Nostrand Company, Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × $9^1/_4$ in., 546 pp., illus., diagrams, charts, tables, $2.90. This book surveys the important facts about the history, present status, and possible future of atomic science. It considers peacetime and wartime applications. Beginning with the earliest theories of the atom and its structure, the growth of thought and knowledge, the development of theories, and the discovery of the phenomenon of radioactivity are described. Atomic particles, modern instruments, and the release of atomic energy are treated. Radiation protection and health physics are also considered.

STEAM TURBINES. By E. F. Church, Jr. Third edition. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Cloth, 6 × $9^1/_4$ in., 531 pp., illus., diagrams, charts, tables, $6. Prepared as text for a short but thorough course for engineering students in their junior or senior years, this third edition has been largely revised and rewritten. Special attention is given to the application of theory in the determination of the principal dimensions of the steam path through the turbine. Emphasis is also placed on the characteristics of high-speed fluid flow, on the effects of vibration, and on the principles of output control. New developments covered include improvements in the determination of nozzle and blade efficiency, failure studies, and new types of construction for high pressures and temperatures.

TECHNICAL DATA ON FUEL. Edited by H. M. Spiers. Fifth edition, revised and enlarged, published by World Power Conference, British National Committee, 201 Grand Buildings, Trafalgar Square, London, England, 1950. Fabrikoid, $4^1/_2$ × $7^1/_4$ in., 517 pp., diagrams, charts, tables, 25s (for sale in U. S. A. by The American Society of Mechanical Engineers, New York, N. Y., $3.75). Providing a wide range of data used in the solution of problems in fuel technology, this book, in its fifth edition, is revised and enlarged to include topics not covered in the previous edition of 1935. Some of the new topics covered are the National Coal Board's classification of British coals, the properties of coal-tar fuels, and the combustion of fuels with oxygen and oxygen-enriched air. Among the sections which are rewritten are the calculation of fluid flow in pipes, the measurement of fluid flow, heat transfer, refractory materials, and metals and alloys.

LA TECHNIQUE DE VIDE. (Collection Armand Colin.) By M. Leblanc. Librairie Armand Colin, Paris, France, 1951. Paper, $4^1/_4$ × $6^1/_2$ in., 187 pp., diagrams, charts tables, 200 fr. This small book on vacuum technology begins with a summary of the kinetic theory of gases. The author then deals with the equipment for the production, measurement, and maintenance of high vacuum. The book also discusses auxiliary equipment and processes.

THERMODYNAMICS. By G. A. Hawkins. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, 1951. Linen, $5^1/_2$ × $8^3/_4$ in., 563 pp., diagrams, charts, tables, $6.50. This book provides a well-balanced treatment of engineering thermodynamics. The major changes in this second edition occur in the following chapters: first law of thermodynamics; the second law and the Carnot cycle; available energy, unavailable energy, and entropy; mixtures of ideal gases and vapors; the flow of gases through nozzles and orifices; and general thermodynamic equations. Significant minor changes occur in other chapters. A new table on the thermodynamic properties of air is added to the appendix.

3100 NEEDED INVENTIONS. By R. F. Yates. Wilfred Funk, Inc., New York, N. Y., 1951. Cloth, 5 × $7^1/_2$ in., 336 pp., $2.95. The more than 3000 suggestions are broadly classified in chapters or chapter sections under a wide variety of headings. In addition to the great general group of suggestions a list of current special problems of particular interest for national defense is included. The early chapters also provide some discussion of the field and of methods of inventive procedure.

ZERSPANUNG UND WERKSTOFF. By E. Brödner. Second edtion. Verlag W. Girardet, Essen, Germany, 1950. Cloth and half cloth, 6 × $8^1/_4$ in., 256 pp., illus., diagrams, charts, tables, half cloth, 18.50 Dm; cloth 19.70 Dm. In two parts, the first part is devoted to the principles of machining and machinability and discusses the effects of cutting fluids and coolants and the various machining operations. The second part deals with ferrous, nonferrous, and plastic materials and includes the various tool steels, hard metals, and diamonds. The appendix contains standards, conversion tables, and a detailed literature review.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

Armed Forces to Claim Half of 1951 Engineering Graduates, EJC Finds

86 Schools Answer EJC Engineering Manpower Commission Survey

BECAUSE 50 per cent of the 1951 class of engineering graduates are either enrolled in the officers' or enlisted reserves or are of draft age, industry will be able to fill only two out of every three jobs currently waiting for young engineers. Industry will need 30,000 engineering graduates per year for the nextt hree years, but only 19,000 will be available to it from the 1951 class of 38,000.

135 Schools Receive EJC Questionnaire

This estimate of the engineering manpower was presented in a statement issued recently by the Engineering Manpower Commission of the Engineers Joint Council. The statement, signed by Maynard M. Boring, chairman of the Statistical Committee of the EJC Commission, was based on a survey of 135 engineering schools accredited by the Engineers' Council for Professional Development. Returns from 86 schools, responsible for 50 per cent of the expected graduates, showed that industry must expect the following depletions from its normal engineering-manpower supply; 11 per cent, who will be commissioned in the Armed Services or Reserves through the ROTC; possibly half of the 16 per cent, who are enlisted members of Reserves or National Guard; and 36 per cent who are of draft age and will most likely be drafted. The civilian and national defense industries will have to rely on the remaining 37 per cent of the graduates and those draft eligibles who may be classified as 4F's.

The diversion of engineering manpower into the Armed Forces during the next few months will be accelerated, the EJC Commission feels, because the brunt of future draft calls will have to be borne by students who were deferred to complete their education. This belief is substantiated by public statements by Major General Lewis B. Hershey, director, Selective Service System.

Reservists In Industry

All graduates are entitled to a 30-day postponement of induction to enable them to enlist in a branch of the service of their choice, or to find employment in a critical occupation in an essential industry which the employer was not otherwise able to fill. Another feature in the critical manpower situation faced by industry is the large number of engineers in key positions who are enrolled in the Reserves. A recent survey showed that 25 per cent of engineers now employed in industry are reservists.

According to Mr. Boring, the Armed Forces need ships, planes, guns, tanks, radar, radio, sonar, and other modern devices of war. These are the result of research, development, design, and other engineering applications by industry.

"Should the selective service system induct the draft eligibles, and there are indications that they will make every effort to do so, there will be only about half of the 38,000 engineering graduates left to fill industrial needs.

The EJC Engineering Manpower Commission was established in response to a request from the Manpower Office of the National Security Resources Board in September, 1950, to prepare a program "for the most effective utilization of engineers in the national effort and make recommendations as to how such a program could be best administered."

The Commission is made up of three representatives of each of the five societies which comprise the Engineers Joint Council—American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers. In addition, three representatives from the American Society for Engineering Education serve on EMC.

50 Million, Current Scale of University Research

MORE than 5200 engineering-research projects, representing annual expenditures of over $50.5 million, are now active in the engineering schools of American colleges and universities.

These figures highlight the 1951 edition of the "Review of Current Research," published this week by the Engineering College Research Council of American Society for Engineering Education.

The new book, which outlines the policies and activities of engineering research in the 91 colleges and universities holding membership in ECRC, is the only complete guide to the current research contributions of engineering schools, according to Gerald A. Rosselot, chairman of the Research Council and director of the State Engineering Experiment Station at the Georgia Institute of Technology, Atlanta, Ga.

In addition to complete research-project titles, the volume shows for each school the names of responsible research administrative officers, a brief digest of policies which govern research projects, and contracts at each institution, the number of personnel engaged in research activities, the annual expenditures, and special conferences and short courses of interest to research workers.

The research projects listed represent the work of more than 11,500 faculty, graduate students, and research engineers.

Copies of the publication, at $2.25 each, may be obtained from the Secretary, Engineering College Research Council, Room 7-204, 77 Massachusetts Ave., Cambridge 39, Mass.

EJC Asks Approval of UPADI Constitution

THE ENGINEERS Joint Council at its meeting in New York, N. Y., April 18, 1951, recommended that constituent societies authorize approval of the constitution recently adopted by UPADI (Pan-American Union of Engineering Societies). James M. Todd, past-president ASME, was nominated as the first U. S. director for UPADI. S. L. Tyler, secretary, American Institute of Chemical Engineers, was nominated as EJC member of the permanent UPADI Committee on Constitution and By-Laws.

These recommendations followed reports by several of the EJC delegates to the constitutional conference, all of whom spoke highly of South American delegates and the work accomplished at the conference.

In another action EJC asked its constituent societies to recommend three members qualified for appointment to the Divisional Committee of Mathematical, Physical, and Engineering Sciences of the National Science Foundation. These recommendations were invited by Dr. Allan T. Waterman, director of the Foundation, in a letter addressed to the EJC. B. A. Bakhmeteff, chairman, EJC Committee on Engineering Sciences, stressed the need for more adequate engineering representation on the National Science Foundation Board. He urged that the EJC recommend a list of qualified engineers from which President Truman could make appointments to fill the vacancy caused by the resignation of Charles E. Wilson. A. A. Potter, past-president ASME, dean, School of Engineering, Purdue University, and Donald H. McLaughlin, president, Homestake Mining Campany, San Francisco, Calif., are the engineering members on the Foundation Board. (Edward E. Moreland, consulting engineer, Boston, Mass., also a member of the board died on June 17, 1951.) The next meeting of the EJC was set for Sept. 21, 1951.

Heat-Transfer Discussions in London to Review Decade of Progress

Preprints of Papers to Be Published by ASME and IME

A REVIEW of developments in heat transfer and in the design of equipment relating to it will be the purpose of a conference sponsored jointly by The Institution of Mechanical Engineers and The American Society of Mechanical Engineers to be held in London, Sept. 11–13, 1951. Co-operating with The Institution of Mechanical Engineers will be engineering organizations from Australia, India, New Zealand, South Africa, Belgium, Denmark, France, Holland, Norway, Sweden, Switzerland, and 30 engineering societies in Britain.

Co-operating with the ASME will be the following. The American Mathematical Society, American Institute of Chemical Engineers, American Chemical Society, American Society of Refrigerating Engineers, American Society of Heating and Ventilating Engineers, American Institute of Physics, American Institute of Mining and Metallurgical Engineers, American Physical Society, Society of Automotive Engineers, Institute of the Aeronautical Sciences, Engineering Institute of Canada.

Some eighty papers have already been submitted covering developments which have taken place in the last ten years. The papers are grouped under the following headings: (1) Heat transfer with change of state; (2) heat transfer between fluids and surfaces; (3) conduction in solids and fluids; (4) radiation, instrumentation, measurement techniques, and analogies, (5) special problems.

American contributions to the program are:

Section I

Heat Transfer With Change of State

Heat Transfer Coefficients of Boiling Freon-12, by *R. J. Yoder*, Elizabeth, N. J., and *B. F. Dodge*, Yale University, New Haven, Conn.

The Effect of Vapor Velocity on Condensation Inside Tubes, by *A. P. Colburn*, University of Delaware, Newark, Del., and *F. G. Carpenter*, Bureau of Standards, Washington, D. C.

Condensation of Vapors on Vertical Banks of Horizontal Tubes, by *B. E. Short* and *H. E. Brown*, department of mechanical engineering, University of Texas, Austin, Texas.

Condensation of Benzene in the Presence of Air, by *J. C. Smith*, School of Chemistry and Metallurgical Engineering, Cornell University, Ithaca, N. Y., and *H. T. Robson*, Union Paper and Bag Company, Savannah, Ga.

Section II

Heat Transfer Between Fluids and Surfaces

Heat-Transmission Problems in High-Speed Flows in Rarified Gases, by *E. D. Kane* and *R. M. Drake*, department of engineering, University of California, Berkeley, Calif.

Measurement of Recovery Factors and Friction Coefficients for Supersonic Flow of Air in a Tube, by *J. Kaye*, *J. H. Keenan*, and *R. H. Shoulberg*, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Heat Transmission to Flat Surfaces, by *A. C. Mueller* and *S. J. Friedman*, chemical engineers, E. I. du Pont de Nemours & Company, Wilmington, Del.

Heat Transfer to Bodies in a High-Speed Rarified-Gas Stream, by *J. R. Stalder*, *G. Goodwin*, and *M. O. Creager*, NACA Ames Aeronautical Laboratory, Moffett Field, Calif.

Temperature Distribution for Air Flowing Turbulently in a Smooth Heated Pipe, by *R. A. Seban*, department of mechanical engineering, University of California, Berkeley, Calif., and *T. T. Shimazaki*, North American Aviation Corp., Downey, Calif.

The Cooling of a Freely Falling Water Drop, by *N. W. Snyder*, department of mechanical engineering, University of California, Berkeley, Calif.

An Experimental Determination of Local Boundary Conductances for an Unbaffled Circular Finned Cylinder, by *V. Paschkis* and *J. Weiner*, Columbia University, New York, N. Y., *D. Gross*, National Bureau of Standards, Washington, D. C.

Prediction of Temperature Gradients in Turbulent Streams, by *W. G. Schlinger*, and *B. H. Sage*, California Institute of Technology, Pasadena, Calif., *V. J. Berry*, Stanolind Oil and Gas Company, Tulsa, Okla., and *J. L. Mason*, AiResearch Mfg. Co., Los Angeles, Calif.

Remarks on the Behavior and Application of Compact High-Performance Heat-Transfer Surfaces, by *A. L. London* and *W. M. Kays*, department of mechanical engineering, Stanford University, Stanford, Calif.

Shell-Side Characteristics of Shell and Tube Heat Exchanger, Parts I, II, III, by *T. Tinker*, Ross Heater and Manufacturing Company, Buffalo, N. Y.

Viscosity of Steam and of Nitrogen at Atmospheric Pressure and High Temperature, by *C. F. Bonilla*, department of chemical engineering, Columbia University, New York, N. Y., *R. D. Brooks*, General Electric Company, Schenectady, N. Y., and *P. L. Walker, Jr.*, Pennsylvania State College, State College, Pa.

Section III

Conduction in Solids and Fluids

Temperature Distribution in Slabs With a Linear Temperature Rise in One Surface, by *M. L. Anthony*, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill.

Temperature Distribution in Slabs With a Linear Temperature Rise in Two Surfaces, by *M. L. Anthony*, Armour Research Foundation.

Temperature Distribution in Composite Slabs Due to Suddenly Activated Plane Heat Source, by *M. L. Anthony*, Armour Research Foundation.

Heat Exchanger Analysis by Electrical Analogy Studies, by *C. F. Kayan*, department of mechanical engineering, Columbia University, New York, N. Y.

Section IV

Convection, Radiation, Instrumentation, Measurement Techniques, and Analogies

The Determination of the Temperature of Nonluminous Flames From the Radiation Intensity of Water Vapor in Near Infrared, by *L. Bernath*, *H. N. Powell*, and *K. Wohl*, department of chemical engineering, University of Delaware, Newark, Del.

Glass-Mat Surfaces as Radiant Heaters, Their Use in Ovens and Driers, by *G. Broughton*, paper engineering department, Lowell Textile Institute, Lowell, Mass.

An Investigation Into the Importance of Chemiluminescent Radiation in Internal-Combustion Engines, by *H. D. Baker*, department of mechanical engineering, Columbia University, New York, N.Y., and *G. L. Laserson*, engineering research laboratory, E. I. du Pont de Nemours & Company, Wilmington, Del.

Heat Transfer From Wires to Gases at Subatmospheric Pressures Under Natural Convection Conditions, by *A. J. Madden, Jr.*, department of chemical engineering, University of Minnesota, Minneapolis, Minn., and *E. L. Piret*, % Maurice Letort, directeur, École Nationale Superieure des Industries Chimiques, Universite de Nancy, Nance, France.

Interferometric Studies on the Stability and Transition to Turbulence of a Free Convection Boundary Layer, by *E. A. G. Eckert*, Xenia, Ohio, and *E. Soehngen*, U. S. Air Force, Office of Air Research, Dayton, Ohio.

Section V

Special Problems

Heat and Momentum Transfer in Turbulent Flow of Mercury, by *S. E. Isakoff*, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del., and *T. B. Drew*, department of chemical engineering, Columbia University, New York, N.Y.

A Correlation of Heat-Transmission Film Coefficients in Fluidized Systems, by *Max Leva*, Pittsburgh, Pa.

Some NACA Investigations of Heat-Transfer Characteristics of Cooled Gas-Turbine Blades, by *H. H. Ellerbrock, Jr.*, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

The Possibilities of the Heat Pump in Canada, by *E. A. Allcut* and *F. C. Hooper*, department of mechanical engineering, University of Toronto, Toronto, Canada.

The Condensation of Air in Hypersonic Wind Tunnels, by *H. G. Stever*, department of aeronautical engineering Massachusetts Institute of Technology, Cambridge, Mass.

Heat Transmission in Internal-Combustion Engines, by *C. E. Tayler*, Sloan Laboratory for Aircraft and Automotive Engines, Massachusetts Institute of Technology, Cambridge, Mass.

All Papers to Be Preprinted

Of the more than 80 papers to be presented at the conference, one third will be by American authors and the remainder by authors residing in Britain, the British Commonwealth, and Western Europe.

In order to devote the major portion of each session to discussion, papers will be presented in abstract form.

The ASME has accepted the responsibility for preprinting papers by American authors. The Institution of Mechanical Engineers is preprinting other papers. Each society will make available its preprints in five individual booklets, one for each session. The ten booklets comprising preprints of American and overseas authors will be on sale by the ASME. Preprints should be available for distribution late in July.

After the conference, discussion of each paper will be set in type and these, together with the ten sets of preprints, will be bound together as a proceedings. The proceedings should be available for distribution early in 1952. Preprints and bound proceedings can be ordered from the Order Department, ASME, 29 West 39th Street, New York 18, N.Y.

Stevens to Offer Doctor of Science Degree

THE Stevens Institute of Technology, Hoboken, N. J., announced recently that it will offer a course of study leading to the degree of doctor of science. The program will be in the newly formed division of applied mechanics and will include specialization in dynamics, elasticity, and hydro- and aerodynamics.

A student may work for his doctorate on a full-time or part-time program, depending on his outside employment, but he should plan to spend one academic year in resident research, Mr. Baker explained. Three academic years, or the equivalent, are required to earn the degree. Among the requirements are a reading knowledge of technical German. Facilities at the service of those taking courses under the Applied Mechanics Division include the Experimental Towing Tank, Fluid Dynamics Laboratory, Carnegie Laboratory of Mechanical Engineering, Kidde Laboratory of Physics; supplemented by aerodynamic facilities at the Guggenheim School of Aeronautics, New York University, and modern computing machines.

Four Industrial Reactor Studies Planned by AEC

THE Atomic Energy Commission recently announced that negotiations are nearing completion with four groups of business and industrial firms under a previously announced program for expanded participation in reactor-development projects and that no additional groups can be admitted at this time.

The four proposals provide for special studies of the practicability of business and industry building and operating reactors for the production of fissionable materials and power. They were submitted by:

The Monsanto Chemical Company, St. Louis, and its associate, The Union Electric Company of Missouri, St. Louis.

The Detroit Edison Company of Detroit and the Dow Chemical Company of Midland, Mich.

The Commonwealth Edison Company and the Public Service Company of Northern Illinois, Chicago.

The Pacific Gas and Electric Company and the Bechtel Corporation of San Francisco.

Agreements have already been signed with the Dow Chemical-Detroit Edison group and with Commonwealth Edison-Public Service of Northern Illinois group. The Pacific Gas and Electric-Bechtel group has indicated its acceptance of the agreement. Negotiations are continuing with the Monsanto Chemical Company and the Commission expects early closing of the agreement with it.

Still in the preliminary discussion stages is a special proposal by the Bendix Aviation Corporation of Detroit, for study of a reactor for the production of isotopes to be built with private funds.

All costs will be borne by the companies with the exception of costs to AEC and its contractors incidental to making information and consultation services available. The distribution of the final report submitted on the project will be determined by AEC.

2600 Attend FPRS Fifth Annual Meeting

WOOD will become more important as the tempo of the defense program increases, according to C. Arthur Bruce, vice-president, E. L. Bruce Company, Memphis, Tenn. In time of war, a pound of wood will be needed for every pound of steel produced.

Mr. Bruce spoke before the Fifth Annual Meeting of the Forest Products Research Society, held recently in Philadelphia, Pa. More than 2600 attended the technical sessions and the wood-industry exhibits.

Roy M. Carter, head of wood-technology and lumber-products merchandising curriculums, North Carolina State College, Raleigh, N. C., was elected president for the 1951 fiscal year.

The ASME Wood Industries Division sponsored a technical session during the FPRS meeting. Its theme was "New Machinery, Machining, and Production Methods."

ROBERT L. THOMAS, SECRETARY-TREASURER, ASME MINNESOTA SECTION, WITH J. G. HENDERSON, STANDARDS ENGINEER, CARBIDE AND CARBON CHEMICALS CORPORATION, SOUTH CHARLESTON, W. VA., AT ASA MIDWEST CONFERENCE.

Engineers Urged to Make Use of Solid Fuel

IT IS up to the engineering profession to prevent the squandering of irreplaceable oil and gas reserves by not burning these fuels in applications where the more abundant solid fuel is both economically and technologically suited, Earl C. Payne, Mem. ASME, consulting engineer, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa., stated before a meeting of the Air Pollution and Smoke Prevention Association of America, held recently at Roanoke, Va.

The coal industry, Mr. Payne continued, was facing that responsibility by proposing to organize a nationwide fuel and equipment consulting service for small steam plants.

The proposal was the result of a survey of files of the Coal Producers Committee for Smoke Abatement. A survey of equipment in 25 cities covering more than 4000 boiler units showed an appalling low level of efficiency.

Almost 25 per cent of the equipment is mechanically defective; 8 per cent is obsolete; 10 per cent overloaded; 30 per cent improperly operated; 21 per cent could use stokers, he said.

Mr. Payne hastened to add that there are many fine examples of well-engineered small plants. The combustion equipment is adequate to burn a variety of coals without nuisance, inconvenience, or excessive maintenance.

In another session, Elmer R. Kaiser, Mem. ASME, assistant director of research, Bituminous Coal Research, Inc., explained that it has now been determined that dust collectors in the boiler breechings do reduce the amount of dust discharged from industrial chimneys, but that the quantity of the combustible content of the dust leaving the furnace is governed by the combustion process.

The basic factors affecting the emission of fly ash and cinders from the burning of coal under boilers, he continued, are type of firing equipment, gas velocities, turbulence of combustion, coal size, dust collection, and dust reinjection.

ASME Section Sponsors ASA Conference

BECAUSE the United States is in a period of "creeping mobilization," industry must take the initiative to maintain a fine balance between military and civilian production so that military requirements can be met without weakening civilian economy, E. D. Foster, Vice-Admiral U.S.N.(Ret.), told the Midwest meeting of the Company Member Conference of the American Standards Association.

The meeting was held in Minneapolis, Minn., and was arranged by the Minnesota Section of The American Society of Mechanical Engineers, in co-operation with 19 other local chapters of national technical societies.

Speaking on the same program, Col. A. E. Mickelsen, chief, Munitions Board Standards Agency, Washington, D. C., stated that standards originated by industry were providing the basis for drastically reducing the different products required for military use.

Other speakers were G. F. Hussey, Jr., Vice-Admiral, U.S.N. (Ret.), who described the functions of the American Standards Association; L. A. Danse, General Motors Corporation; J. G. Henderson, Carbide and Carbon Chemicals Corporation; and H. H. Loeffler, Exeter Paper Company, who discussed the application of standards in industry.

Lee S. Whitson, professor, mechanical-engineering department, University of Minnesota, is chairman of the Minnesota Section. Robert L. Thomas, manager, industrial engineering, Minneapolis-Moline Implement Company, is secretary-treasurer and was responsible for arranging the conference.

Oak Ridge School to Train 75 Industrial Representitives

REPRESENTATIVES of 22 United States industrial firms will acquire specialized training in nuclear engineering at the Oak Ridge School of Reactor Technology during the 1951-1952 term beginning in September.

Of a total of 75 students who will attend the 12-month term, 24 are sponsored by the industrial firms, and eight by Government agencies. The remaining 43 are recent college graduates selected primarily on the basis of their potential contribution to reactor-development phases of the national atomic-energy program.

The School of Reactor Technology was established in March, 1950, at the Oak Ridge National Laboratory to train engineers and scientists in the field of reactor technology.

The industrial and governmental trainees will be paid by their employers during the training period. Recent college graduates will be considered student employees of ORNL during the training.

At the end of the year this group may become available for employment by AEC, its contractors, or other organizations interested in reactor development.

Meetings of Other Societies

Aug. 13–15
Society of Automotive Engineers, West Coast meeting, Olympic Hotel, Seattle, Wash.

Aug. 20–23
American Institute of Electrical Engineers, Pacific general meeting, Multnomah Hotel, Portland, Ore.

Aug. 26–Sept. 1
Illuminating Engineers Society, national technical conference, Shoreham Hotel, Washington, D. C.

Aug. 27–31
National Association of Power Engineers, national convention and national power show, Sherman Hotel, Chicago, Ill.

Sept. 6–7
The Society of Naval Architects and Marine Engineers, autumn meeting, Statler Hotel, Washington, D. C.

(For ASME Calendar of Coming Events see page 607)

Engineer Proposes Bold Scheme of Emigration

SIR FRANK WHITTLE, inventor of the turbojet engine, has proposed a bold scheme of mass emigration of people from Great Britain to less populated areas of the British Commonwealth of Nations as one way to reduce the vulnerability of Great Britain to attack by atomic bomb.

In commenting on Sir Frank's plan which he calls "Operation Commonwealth," *The Engineering Journal* of The Engineering Institute of Canada says, "No proposal that holds such almost boundless possibilities for good should be dismissed casually."

Overpopulation in Britain

Emigration is the answer to Great Britain's extreme vulnerability caused by overpopulation (50 million persons living on land which can support only 30 million) and by the concentration of one sixth of that number in the 680-square-mile area of Greater London, according to Sir Frank.

"Piecemeal emigration," he said, "is useless. Nothing short of a very carefully planned large-scale migration will do. Whole communities must be moved to other parts of the Commonwealth in such a way that they can rapidly become virtually self-contained in their new home—with them must go their tools and, so far as possible, their living accommodations. The whole thing would have to be run like a large-scale military operation. The order in which the people go would be most important. It is clear, for example, that the emphasis should be on the building trades in the initial phase. We could afford this because after about two million people had gone, the need for building further houses in this country would virtually disappear.

"The movement of such enormous numbers of people and the vast quantities of equipment which would have to go with them is an immense task. It would require, for example, 100 voyages of a grossly overcrowded *Queen Elizabeth* to move one million people by sea. Nevertheless, colossal though the task is, it is virtually urgent that we face it.

Plan Seen as Key to Survival

"I believe," Sir Frank said, "that a policy of large-scale planned migration beginning at the earliest possible moment is a vital necessity if the British nation is to survive a third world war, but I also believe that the tremendous effort would not be wasted if we are fortunate enough to escape war. Planned migration is a policy which is equally necessary for security in war and for prosperity in peace.

"These things must be self-evident to any intelligent and well-informed individual—a blinding glimpse of the obvious almost—yet it is a deplorable fact that neither the Conservative nor Labor party leaders have had the courage to say what it is their duty to say. Why? They should know by now that the British people give of their best when faced with a mighty task in which they believe," he concluded.

Who Becomes an ASME Life Member?

AT THE 1950 Semi-Annual Meeting in St. Louis, Mo., the Council of The American Society of Mechanical Engineers amended the By-Laws and Rules pertaining to life membership, the amendments to become effective on Oct. 1, 1952.

Under the present By-Law, Article B5, Par. 12, which will expire in 1952, it is mandatory for Council to confer life membership on any Fellow, Member, or Associate of the Society (1) when he has paid dues for 35 years, or (2) when he has reached the age of 70 after having paid dues for 30 years.

In the amended By-Law, it will be mandatory for Council to confer life membership only on those Fellows, Members, and Associates who have paid dues for 35 years and who have in addition either reached the age of 65 or have retired from regular work.

Life membership can be purchased at any time by any Fellow, Member, or Associate by paying the Society at one time the present worth of an annuity equal to that member's dues for the period for which he is required to pay dues. In most cases this period will be longer under the amended By-Law effective October, 1952, than under the current one.

As in the present By-Law, student membership dues will not be considered as applying to the 35-year-dues payment.

In accordance with the new rule (Article B5 Rule 3) within six months after a Fellow, Member, or Associate has completed 35 years of dues payment, the Society will advise him of the amended life-membership provision and request him to notify the Society when he retires from regular work.

Literature

Instruments

A PERIODICAL review of developments in engineering and physical science relating to the instruments industry was inaugurated by Elliott Brothers, Ltd., of London, with the March, 1951, issue of *The Elliott Journal* which is to appear semi-annually. The next issue will be in September, 1951.

Well illustrated and printed on good paper, the journal contains articles on a high technical level on such subjects as: Pulsed circuits for resistance strain gages, a precision sine-cosine potentiometer, a review of 150 years of instrument making, and others.

The Elliott Brothers have been making instruments for 150 years. While the journal is intended as a "family affair," it should be a welcome addition to the literature of instrumentation.

Drill Drivers

AN American Standard for Split-Sleeve, Collet-Type Drill Drivers, ASA B5.27–1951, was recently published by The American Society of Mechanical Engineers. The standard was developed because the assembly of drill and collet-type driver requires drivers manufactured to close tolerances to insure that collets fit standard drill shanks.

While various methods and mechanisms are used in American industry to drive twist drills, the split-sleeve collet has been particularly popular in the automotive and other mass-production industries for two reasons: (1) Multiple-spindle drill heads can be designed with spindles on a very close center-to-center distance; and (2) bushing plates do not have to be moved when drills are replaced. The split-sleeve collet driver is designed to drive straight-shank drills. In sizes larger than 1/4-drill diameter the drill shank is tanged to insure proper functioning.

Copies of the 8-page standard may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is 45 cents.

Fine-Pitch Gears

AMERICAN Standard on Inspection of Fine-Pitch Gears was recently published by The American Society of Mechanical Engineers. Fine-pitch gears are defined as those of 20 diametral pitch and finer.

The 35-page standard contains the following sections: (1) General; (2) Spur and Helical Gears; (3) Worms and Worm Gears; (4) Bevel Gears; (5) Backlash in Gears; (6) Comparator Layouts; (7) Gear Blanks for Fine-

Pitch Gears; (8) Pin Measurements of Fine-Pitch Involute Spur Gears; (9) Fine-Pitch Master Gears; and (10) Surface Roughness, Waviness, and Lay of Gear Teeth.

The standard divides fine-pitch gears into two classes: commercial and precision. Each group contains several classes, each based on the maximum permissible error. The reason for the two groups is to focus attention on the cost consideration when the transition is made from one group to another. The standard is identical to the one issued by the American Gear Manufacturers Association and designated AGMA 236.02.

Copies may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is $2.50.

Fittings

THE American Standard Steel Butt-Welding Fittings (ASA B16.9-1951) was recently published by The American Society of Mechanical Engineers. The standard is a revision of the 1940 edition.

The new edition extends the size of fittings covered to 24-in. nominal pipe size and includes reducing tees and heavy wall caps. The standard gives over-all dimensions, tolerances, and marking for wrought and cast carbon and alloy-steel welding fittings.

Copies of the 14-page standard may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is 75 cents.

People

ASME Elects Three to Grade of Fellow

THE American Society of Mechanical Engineers elected three members to the grade of Fellow. They are Allan H. Candee, mechanical engineer engaged on research and development, Gleason Works, Rochester, N. Y.; Frederick P. Fairchild, chief engineer, electrical-engineering department, Public Service Electric and Gas Company, Newark, N. J.; and George B. Pegram, special adviser to the president of Columbia University.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

Allan H. Candee

ALLAN H. CANDEE was born in Eureka, Colo., Sept. 13, 1884, and was graduated from Cornell University in 1906 with an ME degree. For more than 30 years he has specialized in the development of methods, machines, and tools for generating gears and has been granted more than 30 patents in this field. Among his inventions in the art of gear cutting are the following: The mathematically correct relieved involute hob; the single-tool planing generator for large spiral bevel and hypoid gears with full adjustability of spiral angles; a modification of the two-tool straight-bevel-gear generator whereby tooth profiles for nonuniform ratio can be produced; and the modification of the two-tool straight-bevel-gear generator with adjustments in the machine whereby the length of tooth contact can be controlled as desired. He is the author of articles and papers on gearing and kinematics including four which were published in Transactions of the ASME, 1929, 1938, 1943, and 1947. Mr. Candee was awarded the Naval Ordnance Development Award, 1946; and the Edward P. Connell Award, by the American Gear Manufacturers Association, 1949. He served the Society as chairman, Rochester Section, 1932; is a member of Sectional Committee B6 on the Standardization of Gears, and is on the Paper Committee, Machine Design Division. He is president of the Rochester Engineering Society.

Frederick P. Fairchild

FREDERICK P. FAIRCHILD was born in Ellsworth, Kan., Jan. 28, 1889. When he was graduated from the University of Kansas in 1910 he received a BSME degree. He has been in responsible charge of the engineering, design, and construction of some of the largest and most important power installations in the country, the most recent of which is the Sewaren Generating Station. He was an early advocate of pulverized-fuel firing and the larger boilers which were made possible by this method of burning coal. He has been a consistent proponent of higher steam pressure and temperatures, which have resulted in marked improvement in efficiency and the better utilization of fuel resources. To this end he has utilized the latest developments in welding techniques and heat-resistant alloys. To make possible the use of the advanced steam conditions on the larger installations, he encouraged the manufacturers to develop high-speed 3600-rpm turbine-generators as opposed to the more conventional lower-speed machines. These improvements have resulted in a steady reduction in the unit costs of generating capacity when adjusted for increasing price levels. At present he is responsible for not only the mechanical engineering, but also the structural and electrical engineering involved in the construction undertaken by his company. As a member of important utility committees and for the last two years, as chairman of the Prime Movers Committee, Edison Electric Institute, he is a utility engineer of national prominence. He has done much to advance the art of power generation. He has had many of his papers published in technical journals.

George Braxton Pegram

GEORGE B. PEGRAM was born in Trinity, N. C., Oct. 24, 1876. When he was graduated from Trinity College (now Duke University) in 1895, he received an AB degree; in 1903 he received a PhD degree from Columbia University. Dr. Pegram, one of the country's leading scientists, who was active in the atomic-energy program since its inception, has been associated with Columbia University since 1900. He was instrumental in marshaling American scientists in support of the war effort. He served on the principal atomic-energy advisory committee of the National Defense Research Committee and the Office of Scientific Research and Development throughout the war. He was chairman of the Division of War Research at Columbia University during the war. From 1913 to 1930 he was dean of the faculty of engineering at Columbia University; in 1937 he was appointed dean of the graduate faculties; and in 1949–1950 he was vice-president of the university. In 1950 he was appointed as a special adviser to the president of the university. He is also scientific and educational consultant to the Oak Ridge Institute of Nuclear Studies in Tennessee. He is the author of research papers in physics, radioactivity, electromagnetic theory, and nuclear physics. Many universities have conferred honorary degrees on Dr. Pegram for his important contributions to science in engineering.

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PAUL T. ONDERDONK, Mem. ASME, engineer for the Consolidated Edison Company, New York, N. Y., was recently elected president of the Technical Societies Council of New York.

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EDWARD W. MILLER, president, The Fellows Gear Shaper Company, Springfield, Vt., was named the 1951 recipient of The Connell Award by the American Gear Manufacturers Association.

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JOHN CHIPMAN, head, department of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass., was nominated president of the American Society for Metals for 1951–1952.

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JESS H. DAVIS, Mem. ASME, president, Clarkson College of Technology, has been elected to succeed Harvey N. Davis (no relation) as president of Stevens Institute of Technology, Hoboken, N. J., on Sept. 1, 1951.

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HARRY P. HAMMOND, Mem. ASME, dean, school of engineering, The Pennsylvania State College, will retire with emeritus rank on Sept. 1, 1951. He will be succeeded by ERIC A. WALKER, director, Ordnance Research Laboratory, and professor and head, department of electrical engineering.

* * *

JAMES BAILEY, Mem. ASME, vice-president, director of research, Plax Corporation, Hartford Conn., received the 1950 John Wesley Hyatt Award of the Society for the Plastics Industry for distinguished achievement in plastics.

ASME NEWS

AIR VIEW OF MINNEAPOLIS, MINN., SHOWING THE BUSINESS CENTER. THE MILL DISTRICT IS IN THE FOREGROUND. MINNEAPOLIS WILL BE THE SCENE OF THE 1951 ASME FALL MEETING, SEPT. 25–28

Minnesota Section Prepares for ASME 1951 Fall Meeting

Hotel Radisson, Minneapolis, Minn., Sept. 25–28

AT THE invitation of the Minnesota Section The American Society of Mechanical Engineers will hold its 1951 Fall Meeting at the Hotel Radisson, Minneapolis, Minn., Sept. 25–28.

The host Section has a membership of 300 mechanical engineers residing in the states of North Dakota, South Dakota, Montana, and Minnesota. Two thirds of these members are concentrated in the twin-city area of Minneapolis and St. Paul. Because of the diversified industry, members in the Minnesota Section are active in almost all professional divisions of the Society.

The Section holds two special meetings each year. One is a social event to which wives of members are invited. The other is a joint affair with one or more local sections of national engineering societies participating. Recently the Minnesota Section sponsored a joint technical meeting at which six other technical societies and six ASME student branches were represented. The Section also assumed the responsibility for sponsoring the Midwest Meeting of the American Standards Association.

Many Attractions in Minneapolis

In addition to the technical program, the Fall Meeting offers an opportunity to visit one of the beauty spots of the nation. Minneapolis is famed in legend as the "land of the sky-blue water." Within the city limits there are 22 lakes, and the Mississippi River, with its historic St. Anthony Falls, flows through deep gorges.

Minneapolis is a major industrial center of the Midwest. The products of its flour mills and linseed-oil industry are shipped throughout the world. In addition, the city is an important producer of agricultural machinery, fabricated metal products, electric machinery, and domestic electric utilities. Some 400 printing and publishing establishments place Minneapolis among the first five printing and publishing centers in the United States. The city also ranks high as a clothing manufacturing center. In fact, some enthusiasts call it "the lingerie capital of the world."

Paralleling its industrial achievements, Minneapolis boasts of the University of Minnesota with its 25,000 day and 1000 evening students. Perhaps better known than even its flour products is the Minneapolis Symphony Orchestra, one of the most traveled symphony orchestras in the country. Founded in 1903, the orchestra is recognized throughout Europe as one of the top five in the world.

Technical Sessions

Some 20 sessions are planned for the technical program. These sessions will be sponsored by the following Professional Divisions and committees: Fuels, Gas Turbine Power, Hydraulic, Industrial Instruments and Regulators Machine Design, Management, Materials Handling, Metals Engineering, Petroleum, Power, and Production Engineering Divisions; Education, Junior, and Safety Committees; and the American Rocket Society.

In addition to the technical program there will be an interesting series of social events and plant trips to some of the industries in and near Minneapolis.

The banquet on Wednesday, the social high light of the meeting, will have as its main speaker, President J. Calvin Brown.

The Roy V. Wright lecture will be given on Thursday, Sept. 27, by John Walker Barriger, III, Mem. ASME, president, Chicago, Indianapolis and Louisville Railway, Chicago, Ill. This lecture honors the late Mr. Wright who was president of the Society in 1931. By means of this lecture the Society hopes to impress on engineers and young people the duties, responsibilities, and privileges of citizenship in a democracy.

On Wednesday, Sept. 26, Dr. Frederick Oederlin, Mem. ASME, managing director, charge of engineering, Sulzer Brothers, Inc., Winterthur, Switzerland, will present the Calvin W. Rice Lecture. This lecture was founded in 1934 and is named after the man who served as the secretary of the ASME from 1906 to 1934. Its purpose is to increase understanding between the engineers of various countries and to stimulate the programs of meetings outside of the Annual Meeting in New York.

One of the interesting events of the meeting will be the conference sponsored by the National Junior Committee on some topic relating to professional development. Junior members chosen by Sections in Region VI will participate in the program.

Petroleum Division Plans Sixth Conference

THE Petroleum Division of The American Society of Mechanical Engineers is formulating plans for its Sixth Annual Petroleum Mechanical Engineering Conference to be held at the Mayo Hotel, Tulsa, Okla., Sept. 24–26, 1951, according to Joseph M. Sexton, chairman of the Division. The ASME Mid-Continent Section will be the host.

Each year this conference is a feature of the Petroleum Division program for the mechanical engineer in the petroleum industry. In a field which many consider strictly chemical, the Division through its programs affords the mechanical engineer a forum for the free discussion of the complex mechanical problems arising from this highly specialized activity. Only the mechanical aspects of design and operation in the production, transportation,

refining, and application of crude petroleum and its products are treated in Division undertakings. Chemical and process problems of the petroleum industry are not considered within the scope of the ASME.

Forty technical papers covering aspects of the production, refining, and transportation phases of the industry are to be sponsored at the Tulsa conference by various operating committees of the Division. One of the feature sessions planned is a symposium on pilot-plant design. This session will present the academic phase of the problem with a paper by an educator, the oil company's view by an engineer from one of the major oil industry's research and development centers, and the independent viewpoint by a representative of refinery designers and contractors.

Another interesting session scheduled by the Division's transportation committee will take up welding of thin-wall, high-strength line pipe. With the popular current interest in cross-country oil and gas transmission lines this session should have a particular appeal. The Production committee of the Division plans to offer a theoretical analysis of sucker-rod loads and development studies of new-type pumping units among its presentations. The Division's material committee will sponsor an analysis of corrosion problems in petroleum refineries and a paper on the development of welding electrodes for special applications among its sessions.

F. J. Daasch of the Gulf Oil Corporation, Tulsa, Okla., is in charge of local arrangements.

In addition to technical sessions, the program will include inspection trips to the Mid-Continent Oil Company Refinery at Tulsa, Phillips Petroleum Research Center in Bartlesville with an evening buffalo-beef barbecue on the Phillips' Woolaroc Ranch, and a banquet which will be addressed by a national prominent oil-industry figure.

How IIR Division Serves Industry and Profession

A GOOD example of how The American Society of Mechanical Engineers, through its professional divisions, serves industry and the engineering profession was provided recently by a newsletter of the Industrial Instruments and Regulators Division. Research projects, useful bibliographies, and translations of technical books, are products of IIR Division programs, mentioned in the letter.

The Division is currently recruiting the co-operation of valve manufacturers and university research organizations in a study of control-valve characteristics and their effect in process applications. Invitations have been sent to 18 universities and to major valve manufacturers. Both have indicated that they are in favor of the studies.

High-Pressure Instruments Symposium

Another frontier is that of measuring extremely high pressures. The Division is interested in the 10,000 to 150,000-psi pressure range. To facilitate exchange of information in this problem of growing importance, the Division is planning a symposium to be held during its annual meeting in 1952. Problems of design of apparatus, for developing, transmitting, and containing such pressures, the Division feels, deserve more attention from engineers in the instruments industry. Members who have special knowledge on this subject should communicate with Paul G. Exline, chairman, IIRD Design Committee, Exline Engineering Company, 710 S. Troost Street, Tulsa, Okla.

Research into component parts of instruments is also occupying attention of Division committees. Recently a request was submitted to the ASME Research Committee for authorization of a project on mechanical pressure elements. The scope of the project is first to compile and correlate data relating to design of Bourdon tubes, and later on diaphragms and bellows. Manufacturers of Bourdon gages will be asked to contribute data; a survey of the literature will be made; and eventually the Division will recommend a standard terminology in the field.

Additions to the Literature

The Division recognizes that instrument information is often unavailable to engineers who need it because its existence is not known or it is locked up in some unfamiliar language. For this reason, the Division's Bibliography Committee is compiling bibliographies on pressure gages, viscosimetry, and automatic control. A revised edition of the Division's publication, "Sources of Information on Instruments," now out of print, will soon be issued.

Other useful publications prepared by the Division are: "Bibliography on Thermostatic Bimetals, Low-Expansion Alloys, and Their Applications," which contains 302 annotated references; "Dynamics of Automatic Controls," which is an English translation of a German work; and "Automatic Control Terms," a pamphlet intended to promote standardization in the field of automatic control.

Albert F. Sperry, president, Panellit, Inc., Chicago, Ill., is chairman of the Division. Some 130 other members are serving on IIR Division Committees. Newest committees are those on Honors, for handling a proposed divisional award, and on Organization, for streamlining the Division committee structure.

According to Mr. Sperry, the Division needs the support of all ASME members in the instruments industry. The Division program offers opportunity for those who wish to serve their Society. Attendance at Division's meetings will help to encourage authors, he said.

The Sixth National Conference of the Division will be held at Houston, Texas, Sept. 10-14, 1951, in co-operation with the Instrument Society of America. A feature of the conference will be a panel discussion on "The Relation of 'Cybernetics' to Industrial Control." Norbert Wiener, who is credited with originating the science of cybernetics, will be the principal discusser. Six other papers will be presented on developments in aviation and geophysics instruments.

L. E. Russell of U. K. Named Rice Scholar

LEWIS E. RUSSELL, of the United Kingdom, was named 1951 Calvin W. Rice Memorial Scholar. He received a BS degree with first class honors in technology when he was graduated from the University of Sheffield. He is a furnace engineer employed in the fuel-oil technical department of the Shell Petroleum Company and hopes to become a consulting engineer in this field. He plans to work for his PhD degree at Massachusetts Institute of Technology, Cambridge, Mass., where he is at present matriculated.

ASME Calendar of Coming Events

Sept. 10-14
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Houston, Texas
(Final date for submitting papers was May 1, 1951)

Sept. 24-26
ASME Petroleum Mechanical Engineering Conference, Hotel Mayo, Tulsa, Okla.
(Final date for submitting papers was May 1, 1951)

Sept. 26-28
ASME Fall Meeting, Hotel Radisson, Minneapolis, Minn.
(Final date for submitting papers was May 1, 1951)

Oct. 11-12
ASME Fuels and AIME Coal Divisions Joint Conference, Hotel Roanoke, Roanoke, Va.
(Final date for submitting papers was June 1, 1951)

Nov. 25-30
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
(Final date for submitting papers was July 1, 1951)

March 24-26, 1952
ASME Spring Meeting, University of Washington, Seattle, Wash.
(Final date for submitting papers—Nov. 1, 1951)

June 15-19, 1952
ASME Semi-Annual Meeting, Sheraton Gibson Hotel, Cincinnati, Ohio
(Final date for submitting papers—Jan. 1, 1952)

June 23-27, 1952
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
(Final date for submitting papers—Feb. 1, 1952)

Sept. 8-11, 1952
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
(Final date for submitting papers—May 1, 1952)

Sept. 8-12, 1952
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland, Ohio
(Final date for submitting papers—May 1, 1952)

Sept. 22-24, 1952
ASME Petroleum Mechanical Engineering Conference, Hotel President, Kansas City, Mo.
(Final date for submitting papers—May 1, 1952)

Nov. 30-Dec. 5, 1952
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1952)

(For Meetings of Other Societies see page 604)

The President's Page

Why Are Some Papers Not Published?

LAST month I gave brief answers to two questions frequently asked: (1) How does ASME handle its technical papers? and (2) Why does it take so long to publish a paper? A third related question, Why are some ASME papers not published? warrants a separate answer.

No one knows how many papers are submitted to ASME in a year. The Publications Committee handles about 400. But, in addition to these, some 40 program-making agencies are handling papers which never reach the Secretary's office because they are not accepted for presentation at a meeting. Moreover, the 73 ASME Sections and the 120 Student Branches also present papers at local meetings. Few of these papers ever reach the Secretary's office. When I use the term ASME papers, I refer only to those processed by the Publications Committee.

What do we mean by publication? In the plan put into effect in 1948, the periodical publications, MECHANICAL ENGINEERING, Transactions, and *Journal of Applied Mechanics*, were supplemented by "preprints" which may be purchased in separate pamphlet form, and hence are "published." In a year ASME publishes in full in its periodicals 250 of the 400 papers. Another dozen or so are condensed for use in MECHANICAL ENGINEERING. Nearly 300 digests of papers available in preprint form, also appear in MECHANICAL ENGINEERING.

Hence it will be seen that the Society "publishes" about three quarters of the papers received by the Publications Committee.

What happens to the other one quarter? There are two answers to this question. (1) A considerable number of authors, particularly nonmembers, send papers directly to the Editor. Many of these are outside our field. Such papers are returned. The remainder are routed through the program-making agencies and are rejected by them. (2) Nearly one quarter of the papers appearing on programs are received too late for preprinting; or are not recommended for publication; or never reach the manuscript stage.

The answer to the question, "Why are some ASME papers not published?" is, therefore: (1) Some responsible ASME group has not recommended publication; (2) there is no completed manuscript; (3) the manuscript is received so late after presentation that publication is denied.

J. CALVIN BROWN, *President*
The American Society of Mechanical Engineers

Actions of the ASME Executive Committee

At a Meeting at Headquarters May 15, 1951

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, May 15, 1951. There were present: J. Calvin Brown, *chairman*, F. M. Gunby, *vice-chairman*, A. C. Pasini, T. E. Purcell, W. M. Sheehan, of the Executive Committee; E. J. Kates, assistant treasurer, H. E. Whitaker, chairman, Finance Committee, E. G. Bailey, past-president, H. R. Kessler, vice-president, H. E. Martin, director at large, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Finance Committee

H. E. Martin, director at large, was appointed to fill the unexpired term on the Finance Committee of A. L. Penniman, Jr., who resigned.

The resignation of R. E. Gillmor, who was appointed this year to serve a five-year term on the Finance Committee, was accepted.

Fuels Division

The establishment of a Fuels Division Custodian Fund to be administered in accordance with Society policy was authorized.

Honors and Awards

Upon recommendation of the Board on Honors, the following awards were approved:

ASME Medal: Glenn Barton Warren, Fellow ASME, manager, turbine division, General Electric Company, Schenectady, N. Y.

Holley Medal: George Rupert Fink, Mem. ASME, president, National Steel Corporation, Detroit, Mich.

Worcester Reed Warner Medal: Jacob Pieter den Hartog, Mem. ASME, professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

Melville Medal: Clayton Hamlin Barnard, Mem. ASME, application engineer, Bailey Meter Company, Cleveland, Ohio, for his paper, "Gas Analyzers for Better Combustion."

Junior Award: John Daniel Stanitz, Jun. ASME, section head, National Advisory Committee for Aeronautics, Cleveland Airport, Cleveland, Ohio, for his paper, "Analysis of the Exhaust Process in Four-Stroke Reciprocating Engines."

Richards Memorial Award: J. Kenneth Salisbury, Mem. ASME, division engineer, General Engineering & Consulting Laboratory, General Electric Company, Schenectady, N. Y., for outstanding achievement in mechanical engineering within 20 to 25 years after graduation.

Pi Tau Sigma Gold Medal Award: Warren Max Rohsenow, Jun. ASME, assistant professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., for outstanding achievement in mechanical engineering within ten years after graduation.

Charles T. Main Topic for 1952

"Engineering as a General Education," was approved as the topic for the 1952 Charles T. Main Award.

Welding Research Council

A contribution from the Development Fund for support of the work of the Pressure Vessel Research Committee of the Welding Research Council was authorized.

Research Committee

Upon recommendation of the Research Committee on High-Temperature Steam Generation, it was voted to extend to Oct. 30, 1951, the agreement between the ASME and Battelle Memorial Institute pertaining to a study of the suitability of selected commercially available alloys for use in superheaters at steam temperatures in excess of 1200 F.

The final report of the Special Committee on Research Policy was accepted and the committee discharged with thanks.

The final report recommends that the Research Committee request each Professional Division Executive Committee to nominate three members from which one member of each Division will be recommended to Council by the Organization Committee for appointment for a three-year term to an advisory committee of the Research Committee.

It was also recommended that the chairman of the Research and Organization Committees, with the aid of the secretary, review the work load of the research manager and recommend the necessary changes in staff organization to permit development of a strong research program.

Spring Meeting

A resolution was adopted expressing thanks on behalf of the Society for the contributions of all committees, organizations, and individuals to the success of the ASME 1951 Spring Meeting.

Applied Mechanics Reviews

The signing of a new contract with the Office of Air Research for support of *Applied Mechanics Reviews* was authorized.

Roy V. Wright Lecturer

The selection of John W. Barriger, president, Chicago, Indianapolis and Louisville Railway Company, Chicago, Ill., as the Roy V. Wright Lecturer was approved.

Certificates of Award

Certificates of Award were approved for the following:

Retiring Chairmen of Sections, 1950–1951: Thompson Chandler, West Virginia; Walter J. Kinderman, Philadelphia; and V. L. Peickii, Southern California.

Retiring Chairmen of Sections, 1949–1950: E. S. Brown, West Virginia; Alexander Cowie, Chicago; Niles H. Barnard, Nebraska, and Alton Kirkpatrick, Boston.

Clarke Freeman, retiring member of the

You Can Afford the 1951 ASME Annual Meeting at Atlantic City

WINTER VACATION IN ATLANTIC CITY, WHERE THE 1951 ASME ANNUAL MEETING WILL BE HELD AT THE CHALFONTE-HADDON HALL, NOV. 25–30

(Four years have passed since the ASME last held a meeting in Atlantic City. In that time the hotels, of which there are many, are prepared to accommodate guests with excellent service throughout the year; the Boardwalk, with its places of entertainment and well-stocked shops, is still one of the high lights of a trip to Atlantic City; and the best of all is the winter weather, which is milder than one is accustomed to expect further inland. There are four beautiful golf clubs surrounding the resort and golfers whose home clubs are locked by snow during the winter months make frequent visits to Atlantic City to enjoy their favorite sport. Atlantic City's growth into a full-fledged city has also resulted in its becoming a hub of transportation—many trains, planes, and buses arrive and leave every day.)

Board on Honors and the Medals Committee; Harold M. King, Lynn, Mass., for long-time service to the Boston Section.

Commemorative Postage

Support of a proposal by the American Society of Civil Engineers for the issuance of a commemorative stamp to honor the engineering profession was approved.

Civil Engineers of France

The secretary was requested to extend good wishes to the new secretary of the Society of Civil Engineers of France, Georges Ville, who succeeds Paul Lecomte, now secretary emeritus.

Appointments

Appointments on committees and joint activities recommended by the Organization Committee were approved.

D. Robert Yarnall, was appointed to serve as ASME representative on the John Fritz Medal Board to fill an unexpired term to the year 1952.

The following presidential appointments were confirmed:

H. E. Martin, W. L. Cisler, J. L. Walsh, M. X. Wilberding, to Federal Civil Defense Conference; J. V. Grimaldi, to President's Highway Safety Conference; William P. Saunier, to University of New Hampshire, Inauguration of President; William A. Stutske to University of Toledo, Inauguration of President; George R. Rich to Massachusetts Institute of Technology, Dedication of Hydrodynamics Laboratory; William M. Murray to Lowell Textile Institute, Inauguration of President.

ASME Standards Workshop

Piping Systems

F. T. CLARKE, supervisor of safety, General Electric Company, was recently appointed chairman of the Sectional Committee on Scheme for Identification of Piping Systems, A13. His group will undertake revision of the 1947 American standard on the basis of recommendations made by the ASA General Conference held in October, 1950. In general, these recommendations favored legend markings for purposes of primary identification, and color markings for such secondary purposes as indicating nature of contents, that is, whether or not the material is in itself hazardous to life or property, with the alternative that nature of contents could also be indicated by legend.

A subcommittee has also been appointed to review definitions.

Drafting Manual

PROGRESS was reported by the Executive Committee of Z14 on Drawing and Drafting Practices which met recently in Lansing, Mich. Six of the proposed 16 sections of the new revision are in draft form.

When completed, the 16 sections will cover all aspects of drawing and drafting and will be known as "American Drafting Standards Manual."

Graphic Presentations

SECTIONAL Committee on Graphic Presentations has revision of three standards under way: (1) Time Series Charts, Z15.2-1939, which will be expanded and brought up to date; and (2) Engineering Slides and Charts of Lantern Slides, Z15.1-1932, which will be combined with (3) Engineering and Scientific Graphs for Publication, Z15.3-1943. The principal reason for the revision is the trend among authors to use their drawings for both lantern-slide preparation and for publication.

The new standards will facilitate the preparation of drawings suitable for this dual purpose.

Compressed Air-Machinery

A DRAFT of a proposed revision to Safety Code for Compressed Air-Machinery was recently considered by the Sectional Committee on Safety Code for Compressed Air-Machinery, B19. The draft was prepared by a task group headed by R. M. Johnson, who is chief engineer, test department, Ingersoll-Rand Company, Phillipsburg, N. J., and H. W. Whiting, chief engineer, compressor division, Worthington Pump and Machinery Corporation, Buffalo, N. Y. The revision includes recommendations on maintenance and operation and covers extensively problems encountered in compressed air systems, such as lubrication.

Cycle of Activities

STANDARDIZATION activity in the ASME builds up to a peak during May and June when committees schedule meetings to complete work under way before vacation season begins. Normally most of the meetings are held in New York, with occasional meetings scheduled elsewhere. This year meetings were held in Toronto, Detroit, Lansing, and Washington, D. C. This pattern has changed noticeably during the last year because members of standardization groups have been called into the Government. About half of the recent standardization-committee meetings have been held in Washington.

The second annual peak in standards activities occurs during the first week in December, when most groups take advantage of the presence of their members at the Annual Meeting to hold standards discussions.

Standard Medal

UNDER consideration by the American Standards Association is the establishment of a medal to give recognition annually to an individual who has made substantial contributions to the field of standardization or who has taken leadership in standardization.

Last year the ASA established the Howard Coonley Medal to give recognition to an executive who has fostered standardization by encouraging the use of standards by industry.

Howard Coonley, Assoc. ASME, consultant, National Security Resources Board, Washington, D. C., was the first recipient.

Screw Threads

AT THE recent London conference on unification of nut and bolt dimensions, British, Canadian, and American delegates representing industry and the military of their respective countries agreed to change the unified screw-thread standard for the $^1/_2$-in. size from 12 to 13 threads per inch. This action was taken to expedite implementation of the unification agreement because many large manufacturers are committed to the 13-thread per inch $^1/_2$-in. screw standard.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of \$3.50 per quarter or \$12 per annum for members, \$4.50 per quarter for nonmembers, payable in advance.

New York 8 West 40th Street	Chicago 84 East Randolph Street
Detroit 100 Farnsworth Avenue	San Francisco 57 Post Street

Men Available[1]

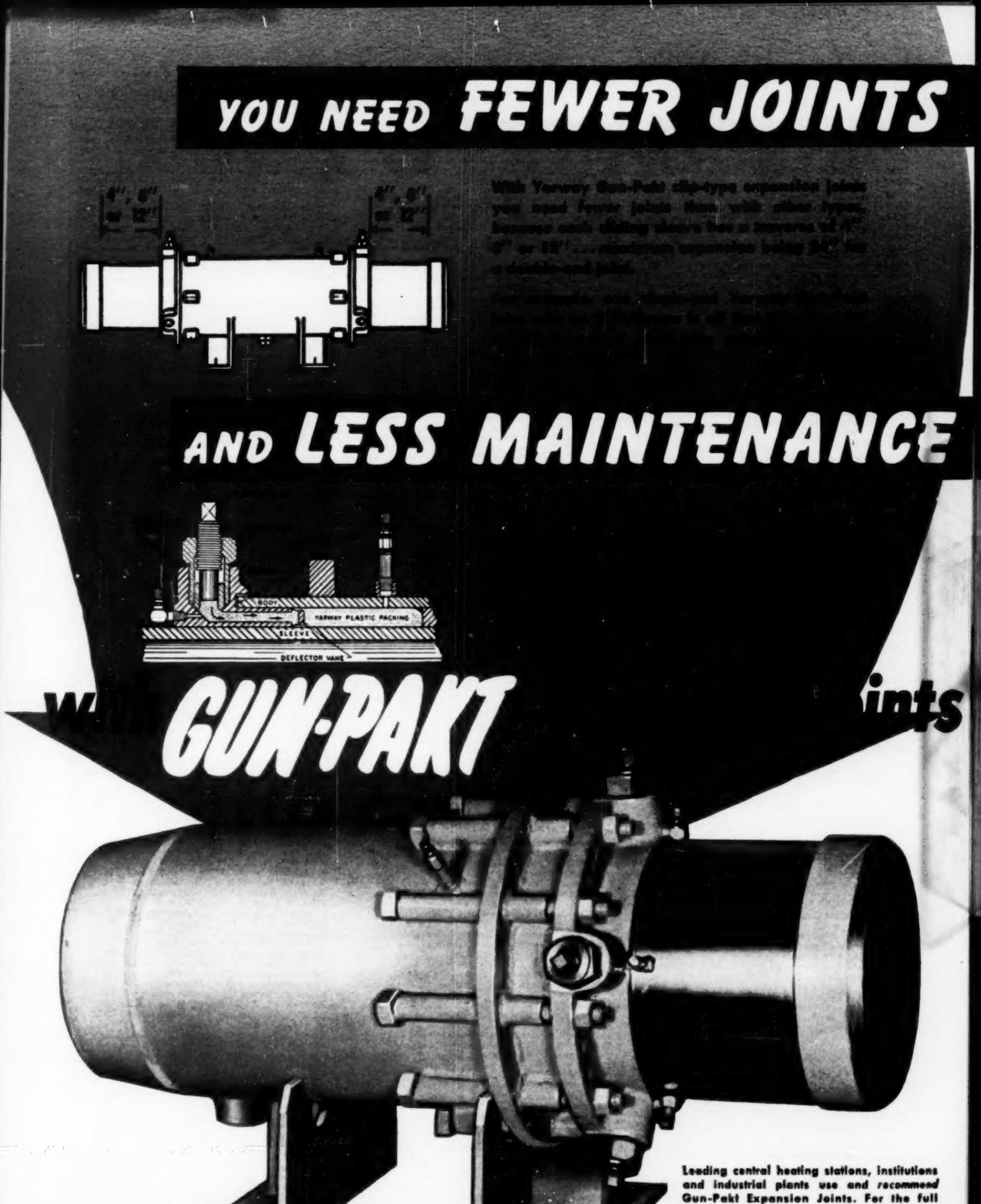
Plant Superintendent or Engineer, 39, 16 years' executive, technical, and practical experience in metal industries. Supervision over construction, plant layout, equipment, tooling, and operation cost. Prefers Milwaukee area. Me-829-101-C.

Designer, 32, five years' experience on heavy machinery, administrative experience (Major in last war), desires position with greater responsibilities leading up to chief engineer. Me-830-54-C.

Manufacturer's Representative, 27, married, MS in mechanical engineering (metallurgical design), five years' production and design experience. Position must require technical background. Available for interview in late June. Prefers San Francisco. Me-831-515-D-2.

(*ASME News continued on page 612*)

[1] All men listed hold some form of ASME membership.



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Mechanical Engineer, BME, June, 1950, some aircraft structural testing, machine shop, airplane mechanic experience. Familiar with electric strain gages. Desires research, development position in New York, N. Y. Me-833.

Design Engineer, BSME, 30, ten years' varied engineering experience, five and a half years' designing heavy processing machinery. Desires position in design or development with small company. East. Me-834.

Positions Available

Senior Industrial Engineer, 27-40, degree in industrial engineering, business administration, or its equivalent. Should be able to handle merchandising and warehousing problems; have a knowledge of paper handling, retail chain operation, inventory control, and business-machine usage. Prefer individual who has the ability to analyze problems using an engineering approach with good knowledge of IBM equipment. Knowledge of tabulating, with retail background desirable. $8000-$10,000. Chicago, Ill. Y-5453.

Staff Engineer, air conditioning, ventilation, and dust control, 33-45, BSME, specialized in heating and ventilating, up to ten years' experience in this field. Will supervise design and layout of industrial heating and ventilating, dust-collecting and air-conditioning systems. Must be able to design, lay out, write specifications, and promote job from inception to completion. Must have thorough knowledge of modern equipment, piping, and controls. Some traveling. $5400-$6300. N. J. Y-5455.

Chief Design Engineer, 35-50, college graduate, with broad engineering training, to consult and advise on highly specialized engineering problems. At least ten years' experience in supervising and directing design and drafting activities relative to structures, machinery and equipment, plant layout, and other types of plant engineering projects. Analyze design and drafting data, results of computations, application of engineering principles or complex engineering data, to determine the logical solution for design or drafting problems. Supervise machine-design work submitted to outside engineering consulting firms for execution. $7400-$8700. N. J. Y-5456.

Production Manager, background in manufacturing practice in machine shop and assembly, familiar with engineering practice, including machine design, tolerances, etc. Will take complete charge of work in production planning; office procedure for production control; and follow-up on flow of work. Will report to factory manager. $8000-$9000. R. I. Y-5468.

Executive Engineer, 35-45, mechanical graduate, at least ten years' product design and development experience in combustion and heat-transfer equipment, to act as chief engineer of portable-heater division manufacturing highly engineered devices for commercial and military purposes. $9000-$10,000. Midwest. Y-5469-T-7804.

Mechanical Computer, several years' experience in design work on the handling of computers, preferably fire-control systems, and preferably one who has used the gyroscope-type computers. It will be a functional-analysis type of work and will require someone with an over-all experience. Salary open. New York, N. Y. Y-5472.

Chief Engineer, 35-50, mechanical graduate, ten years' or more experience covering design, estimating, production, and installation of industrial heating furnaces. $10,000-$15,000. East. Y-5473.

Production Manager, 40-50, with heavy machinery and sheet-metal experience, to be responsible for production planning, assembly, etc., for metal-products firm. $8000-$10,000. Y-5474.

Engineers. (*a*) Senior mechanical engineer for apparatus division of a communication manufacturing company, eight to ten years' experience in design work, to design for production from a handmade model incorporating features which allow for ease in manufacture and insures long life. Thorough knowledge of the strength of materials, hardening of steel for wear, and the design of parts to produce long life from the viewpoint of wear and corrosion protection, such as is required from telephone equipment. (*b*) Mechanical engineer, three to five years' experience in design work. Duties same as above. Upstate New York. Y-5479.

Fuels Engineer, mechanical graduate, 30-35, eight to ten years' combustion-engineering experience covering oil and gas-fired industrial furnaces to plan new installations and conversions, prepare specifications, supervise tests, etc. $6000-$8000. N. Y. Y-5500.

Manufacturing Engineer, over 42, mechanical degree, at least five years' experience as a manufacturing engineer, with broad knowledge of materials such as brass, aluminum, die castings, stainless-steel sheet, and plastics. Will be responsible for modification of design of new products developed by research and development engineers, to enable these products to be placed in production, and to be manufactured most efficiently. Redesign or modification of design of present products in order to improve manufacturing efficiency. Tooling in connection with both present and new products. Estimating and preliminary budgeting of manufacturing costs, present and new products. Some methods engineering, including plant layout. $7500-$8000. N. J. Y-5512.

Director of Engineering, 40-50, thorough mechanical-engineering background in heavy equipment, for company manufacturing large industrial filters. Should also understand the chemistry of water, since major customers are paper, chemical, and petroleum industries. Should have organizing ability as well as skill in product and process research and development. Must be able to deal successfully with client engineering executives. Over $12,000 plus bonus. New York, N. Y. Y-5525.

Building Maintenance Engineer, under 50, mechanical-engineering graduate, at least five years' steam-power, heating, and general building-maintenance experience, to supervise power-plant operations, maintenance, cost records, and plan improvements. $8000-$9000. Brooklyn, N. Y. Y-5534.

Designer-Draftsman four or five years' experience on mechanical work on industrial or commercial buildings, including plumbing, heating, ventilation, air conditioning, fire protection, inside sprinklers, and outside yard piping, boiler-plant work, boiler-plant layout, auxiliaries and piping. $5200-$6240. New York, N. Y. Y-5558.

Plant Engineer, 35-45, graduate mechanical, at least ten years' experience in heavy industry and/or process industry, five years of which should have been in a supervisory capacity. Will work directly under the production manager and should be capable of handling the technical and administrative functions of an engineering department for manufacturers of paper and paper products. About $10,000. South. Y-5579.

President for company engaged in the manufacture of electrical automotive devices; 35-48, graduate electrical or mechanical engineer. Must have had manufacturing experience and preferably some sales experience. Management ability more important than technical. $15,000-$20,000 with possibility of bonus. Midwest. Y-5583.

Assistant to President, up to 38, mechanical or civil, five to six years out of school, experienced in solving operating problems. Knowledge of foundry operations helpful. Will assist president on foundry and branch operating problems and overcoming them. Will be trained in foundry operations. $6500-$7500. Chicago, Ill. R-7786.

Staff Engineer, over 35, chemical or civil, with five to ten years' experience on chemical-plant design, layout of plant, and equipment for manufacture of phosphate. Take complete charge of initial design and later follow through on construction and installation of equipment. Must know phosphate problems thoroughly and be able to determine type of process to use to convert phosphate to chemical fertilizer. $15,000. Headquarters, Chicago, Ill. R-7834.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after July 25, 1951, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ABRAMS, ABRAHAM H., Brooklyn, N. Y.
ANGEL, CHARLES M., Huntington, W. Va.
BAILEY, ARTHUR W., Kissimmee, Fla.
BARNUM, STARR H., 3RD, New Haven, Conn.
BARTHALON, MAURICE, Paris, France
BASS, MELVYN L., Jamaica, N. Y.
BAYS, A. H., Trumann, Ark.
BELES, FRANK J., Milwaukee, Wis.
BERRY, JAMES F., San Francisco, Calif.
BIGNELL, HILARY G., Hollywood, Calif.
BUCKLEY, KENNETH H., Pittsburgh, Pa.
BURKE, DALE H., Toledo, Ohio
COLWELL, L. V., Ann Arbor, Mich.
COMPTON, WARREN E., Chicago, Ill.
CORNIELES, RAMON E., Mene Grande, Zulia, Venezuela, S. A.
DAMERON, H. A., JR., Great Falls, S. C.
DANG, SANT LAL, Delhi, India
DAYTON, CEDRIC L., New York, N. Y.
DONAHUE, GEORGE F., Manhasset, N. Y.
DORSEY, HARRY A., Worcester, Mass.
DOTZENROTH, PAUL N., Chicago, Ill.
DUNCAN, F. R., Oak Ridge, Tenn.
FARRAR, EUGENE M., Culpeper, Va.
FINN, PAUL A., Malverne, N. Y.
FORSTER, HANS W., Eden, N. Y.
FRECH, HARRY E., JR., St. Louis, Mo.
FRY, JAMES P., JR., Houston, Texas
FUNK, MAX O., New York, N. Y.
GEISELMAN, FRANK R., Catonsville, Md.
GITTLER, HARVEY, Yonkers, N. Y.
GOLDSON, HENRY, Woodmere, N. Y.
HAMILTON, REX R., Bellerose, N. Y.
HARDY, ALFRED J., Jersey City, N. J.
HARGAN, AUGUSTUS D., Bayonne, N. J.
HARRIS, DAVID W., Seattle, Wash.
HAYES, GEORGE T., Hicksville, N. Y.
HEAP, JAMES C., Oak Park, Ill.
HENDERSON, F. J., Detroit, Mich.
HENNING, WILLIAM W., Melrose Park, Ill. (Rt&T)
HENRY, ROBERT P., Chattanooga, Tenn.
HOBSON, J. R. A., JR., Kew Gardens, N. Y.
HUGHES, GROVER W., Fayetteville, Ark.
JARRARD, DAVID W., La Oroya, Peru, S. A.
JENNINGS, J. K., Mexico, D.F., Mex.
JOHNSON, WARREN D., Portland, Ore.
KAMBIC, STANLEY F., LaGrange Highlands, Ill.
KEATES, RICHARD L., Pittsburgh, Pa.
KELLS, E. L., Milwaukee, Wis.
KRAUSSER, JOHN W., Cincinnati, Ohio
LA BRIE, THEODORE J., Massapequa, N. Y.
LAIS, LUCIO, Reading, Pa.
LA PRAIRIE, CHARLES, Montreal, Que., Can.
LARA, L. ALBERTO, Bogotá, Colombia, S. A.
LEINEWEBER, WILLIAM F., JR., Greenville, S. C.
LIPSCOMB, CHARLES R., Pottstown, Pa.
LUGRIN, CARL P., New York, N. Y.
McDERMAND, R. F., Toronto, Ont., Can
McFATE, WILLIAM M., Berkeley, Calif.
McKANE, R. H., Charleston, W. Va.
McMEANS, RICHARD D., Youngstown, Ohio
McNALL, PRESTON E., JR., Madison, Wis.
METTER, RICHARD W., Wilmington, Del.
MILLER, JOHN H., Newark, N. J.
MOORE, SHUMAN H., Los Angeles, Calif.
MURPHY, F. D., JR., Derby, Me.
NEWBERG, ARTHUR H., Tulsa, Okla.
NORTON, WALTER J., New York, N. Y.
OLSEN, WILLIAM C., Raleigh, N. C. (Rt)
PAGINI, NANDO A., West Bridgewater, Mass.
PHILLIPS, WAYNE E., Corvallis, Ore.
PRATHER, MARVIN E., Pittsburgh, Pa.
ROBBINS, BRIAN G., London, England
ROSEBERRY, C. V., East Pittsburgh, Pa.
RUBINSTEIN, HERBERT J., Los Angeles, Calif.
RUDISILL, DEITZ A., Lenoir, N. C.
RYAN, ROBERT E., Davenport, Iowa
SANGHAVI, T. M., Bombay, India
SARTORIUS, CARL J., Knoxville, Tenn.
SAVAGE, WILLIAM F., Lexington, Ky.
SAWYER, CHARLES H., Pittsburgh, Pa
SCHARPF, OTTO, Milwaukee, Wis.
SCHARRER, GUNTHER, Mexico, D. F., Mex.
SHUMAN, E. C., Toledo, Ohio
SICARD, ENRIQUE, Bogotá, Colombia, S. A.
SIMPSON, WILLIAM B., New York, N. Y.
SINGH, R. P., Lucknow, India
SMITH, BARNARD E., University Station, N. Dak.
SMITH, CLEMENT C., Longmeadow, Mass. (Rt&T)
SUROWIAK, STANLEY H., Windsor, Ont., Can.
TEMPLETON, DONALD J., River Edge, N. J.
THOMSEN, FRANK J., San Diego, Calif.
TOEPEL, R. O., Albert Lea, Minn.
TRADLER, MARVIN M., Poland, Ohio
VAN HORN, NORMAN H., Detroit, Mich.
WONG, GEORGE G., Mt. Royal, Que., Can.

(*ASME News continued on page 614*)

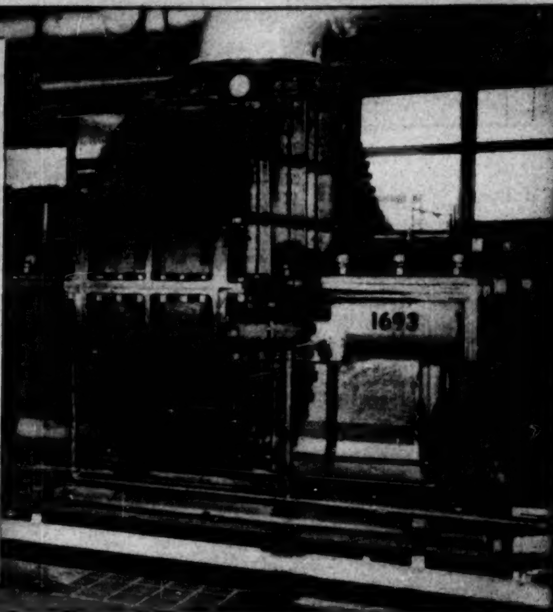
NEW R·C EXHAUSTER

pays its own way

By replacing a 30-year-old battery of three steam-driven gas exhausters with a new, high-capacity, electrically-driven R-C unit, important advantages were gained, in a large industrial plant:

1. **The one new unit carries the base load.**
2. **Steam needed for 5 other steam-driven exhausters, carrying partial load, is substantially reduced because of slower speeds.**
3. **Heat balance in the plant is maintained.**
4. **Savings in total power cost will pay for the new installation in about one year.**

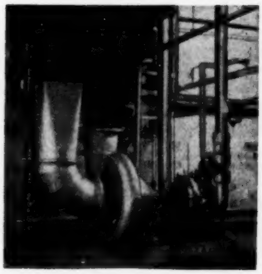
These very satisfactory results were obtained by careful evaluation of all the factors before deciding upon the type of equipment . . . and then by specifying an R-C Rotary Positive Gas Exhauster that will do the work at low operating cost.



Type RCGH Rotary Positive Gas Exhauster, driven by 450-hp synchronous motor. Capacity, 20,600 cfm.

Even though your equipment to handle gas or air may still have years of life, it may be sound economy to replace it with modern, efficient, R-C units of the right type, size and drives to best meet your needs. Our engineers will help you analyze your problem and make unbiased recommendations of either Rotary Positive or Centrifugal equipment, depending upon your specific conditions. This *dual choice* is an exclusive R-C advantage.

With capacities from 5 cfm to 100,000 cfm, R-C units can be closely matched to work requirements, for dependable, economical performance. At Roots-Connersville, almost a century of blower building experience is at your service, without obligation.



Single-stage, Type OIB Centrifugal Blower in food processing plant. Steam turbine drive; capacity 12,000 cfm.

ROOTS-CONNERSVILLE BLOWER CORPORATION
151 Michigan Avenue, Connersville, Indiana

ROOTS-CONNERSVILLE

BLOWER BUILDERS · R-C · SINCE 1854

ONE OF THE DRESSER INDUSTRIES

WRIGHT, REED M., Salt Lake City, Utah
ZIMMERMAN, RICHARD H., Columbus, Ohio

CHANGE IN GRADING

Transfers to Member and Associate

ADKINS, JAMES E., Winston-Salem, N. C.
BALDWIN, NEIL A., Homewood, Ill.
BENDELIUS, ALBERT, Ridgefield, N. J.
BORST, ROBERT O., San Diego, Calif.
GRASSI, ROBERT N., Prospect Park, Pa.
HARRISON, CHARLES G., Detroit, Mich.
JOHNSON, ASHMORE C., Downingtown, Pa.
LESTER, SAUL P., Bronx, N. Y.
LEWIS, EARL R., JR., West Hartford, Conn.
MCCORKLE, LEE R., Chicago, Ill.
MCLEISH, DUNCAN R., Indianapolis, Ind.
ROSSIE, JOHN P., Omaha, Nebr.
STOECKINGER, RICHARD F., Kokomo, Ind.
STOLPER, WALTER H., Los Angeles, Calif.
TURNER, LEWIS, New York, N. Y.
WALDIE, GEORGE A., Columbus, Ohio

Transfers from Student Member to Junior.....900

Obituaries

Frank Burr Bigelow (1871–1950)

FRANK BURR BIGELOW, chairman of the board, Bigelow Liptak Corp., Detroit, Mich., died May 26, 1950. Born, Washington, D. C., March 30, 1871. Parents, Benjamin F. and Marie (Burr) Bigelow. Education, public schools. Married Flora Edson Miller, 1897 (died 1944); son, Truman M. Mem. ASME, 1907. He held many patents on furnaces and furnace parts. Survived by granddaughter, Virginia B. Bigelow, Detroit, Mich.

George Wetmore Colles (1871–1951)

GEORGE W. COLLES, consulting engineer, operator, Rosharon (Texas) Waterworks, died April 12, 1951. Born, New York, N. Y., Feb. 16, 1871. Parents, George W. and Julia K. (Nelson) Colles. Education, BA, Yale University, 1892; ME, Stevens Institute of Technology, 1894; MS, Columbia University, 1900. Married Ella Couche Robertson nee Feador, 1921 (died 1937). He wrote several papers which were published in technical and scientific journals. Jun. ASME, 1895; Mem. ASME, 1901. Survived by sister, Gertrude Colles, Morristown, N. J.

Joseph Roy Darnell (1892–1951)

JOSEPH R. DARNELL, patent consultant, Vapor Blast Manufacturing Co., Milwaukee, Wis., died Jan 4, 1951. Born, Richmond, Ind., Nov. 16, 1892. Parents, John C. and Elizabeth (Thomas) Darnell. Education, 3 years, Earlham College. Married Hazel L. Meek, 1917. Author of "Boiler Fireman's Handbook," "For Amateur Inventors Only," and several bulletins and papers on combustion problems. Mem. ASME, 1942. Survived by wife and two daughters, Mrs. Marian D. Bishop, Pittsburgh, Pa., and Mrs. Dorothy D. Gauthier, Bangor, Mich.

John Theodore Faig (1875–1951)

JOHN T. FAIG, president of departments, Ohio Mechanics Institute, Cincinnati, Ohio, died April 8, 1951. Born, Lexington, Ky., Feb. 5, 1875. Parents John and Louisa (Hurst) Faig. Education, BME, University of Kentucky, 1894; ME, 1897. Married Frances Wiley, 1909. Jun. ASME, 1897; Mem. ASME, 1905; Fellow ASME, 1943. Served the Society as chairman, Committee on Education and Training, 1923–1929. Served as representative, American Engineering Council, 1924–1927. Contributed several articles to technical engineering journals.

James Logan Fitts (1866–1951)

JAMES L. FITTS, mechanical engineer, inventor, and a member of The Franklin Institute for 67 years, died April 12, 1951, in Abington (Pa.) Memorial Hospital. Born, Philadelphia, Pa., Aug. 16, 1866. Parents, Robert Berkley and Esther M. (Logan) Fitts. Education, public schools; ICS. Married Julia Mills. Mem. ASME, 1913. He held 39 patents in the steam-heating field. Survived by three children, a son, J. Logan, Bordentown, N. J., and two daughters, Mrs. Irene (Alfred N.) Austin, Philadelphia, Pa., and Mrs. Frances (Charles N.) Wilkins, Glenside, Pa.

Newenham Acton Gray (1878–1951)

NEWENHAM A. GRAY, consulting mechanical engineer, D. J. Murray Manufacturing Co., Wausau, Wis., died March 30, 1951. Born, Naini Tal, Punjab, British India, Nov. 1, 1878. Parents, John Stuart and Mary (Waters) Gray. Education, Eton College; MA, University of Cambridge, 1902; CE, University of Zurich, 1905; postgraduate work, University of Göttingen. Married Anne MacManus, 1926. Mem. ASME, 1930. Survived by wife.

William Floyd Hunt (1872–1951)

WILLIAM F. HUNT, retired mechanical and calculating engineer, died at the Waterbury (Conn.) Hospital, April 13, 1951. Born, Candor, N. Y., June 12, 1872. Parents, Charles Wallace and Frances (Bush) Hunt. Education, ME, Cornell University, 1894. Married Margaret Brakely, 1894 (died 1905). Married 2nd, Julia Lucy Pearson, 1907. Jun. ASME, 1894; Assoc. ASME, 1903. A specialist in the development of equipment to facilitate the mass movement of goods in production, he had worked as a consulting engineer for the Free Port of Copenhagen and for the London Underground Railway. Many U. S. patents for materials-handling equipment were granted to him. He is the author of "Handling Materials in Factories" and several technical papers. Survived by wife and son, Pearson, a sister, Mrs. Frances H. Pray, and two granddaughters.

August Richard Maier (1901–1950)

AUGUST R. MAIER, director of engineering, Oil Well Supply Co., Dallas, Texas, died Oct. 27, 1950. Born Stuttgart, Germany, Aug. 1, 1901. Parents, August and Emma (Bauer) Maier. Education, Diplom Ing., Stuttgart Technische Hochschule, 1924; extension courses, Purdue University. Naturalized U. S. citizen, Dallas, Texas, February, 1934. Married Johanna Roth, 1931; daughter, Jean. Assoc-Mem. ASME, 1930; Mem. ASME, 1935.

Robert Langworthy Richmond (1912–1951)

ROBERT L. RICHMOND, vice-president and director, Potdevin Machine Co., Brooklyn, N. Y., died April 15, 1951, in New York Hospital. Born, Yonkers, N. Y., March 28, 1912. Parents, Julian and Florence R. Richmond. Education, BSME, Worcester Polytechnic Institute, 1935. Married Elizabeth Rand, 1936. Jun. ASME, 1935. Survived by wife and two children, Susan Lee and Robert Rand; his mother and two brothers, J. Henry and H. Thomas A.

John Alfred Sether (1879–1950)

JOHN A. SETHER, chief engineer, Hotel St. George, Brooklyn, N. Y., died Nov. 6, 1950. Born, Arendal, Norway, July 28, 1879. Parents Martin and Nela (Ohmont) Sether. Education, public schools; ICS. Naturalized U. S. citizen, New York, N. Y., 1905. Married Hilma Carlson, 1905. Assoc-Mem. ASME, 1927; Mem. ASME, 1935. Survived by wife and four children, Mrs. Ethel (M.) Friedman, Valley Stream, L. I.; Areld, Sermandina, Fla.; Malvin, Brooklyn, N. Y.; Howard, Upton, Mass.

Sharon LaMarr Smith (1897–1951)

SHARON L. SMITH, assistant mechanical engineer, Atchison, Topeka & Santa Fe Railway, Topeka, Kan., died March 18, 1951. Born, Kokomo, Ind., Dec 14, 1897. Parents, Charles N. and Pearl (Moore) Smith. Education, BSME, Purdue University, 1922. Married Glessna Thompson, 1923. Mem. ASME, 1949. Survived by wife, two daughters, Barbara J. and Marilyn J.; a son, S. LaMarr, Jr., Kansas City, Mo.; a grandchild; a sister, Mrs. Roy L. Mossberg, Fort Wayne, Ind.; and a brother, W. W. Smith, College Station, Texas.

Albert Vigne (1899–1951)

ALBERT VIGNE, president, Bronze Alloy Co., St. Louis, Mo., died April 3, 1951, at his home in Webster Groves, Mo. Born, Rio de Janeiro, Brazil, S. A., Jan. 25, 1899. Parents, Albert and Fredericka (Shular) Vigne. Education, private military academy; Liceu de Artes, Campos, Brazil; Escola Politecnica, Rio de Janeiro, Mechanics, 1912–1917. Married Nancy Clark Smith. Assoc-Mem. ASME, 1931; Mem. ASME, 1935. Survived by wife and son, Albert, Jr., U. S. M. C. presently serving at the Marine Base, Camp Lejeune, N. C.

ASME Master-File Information

(Not for use of student members)

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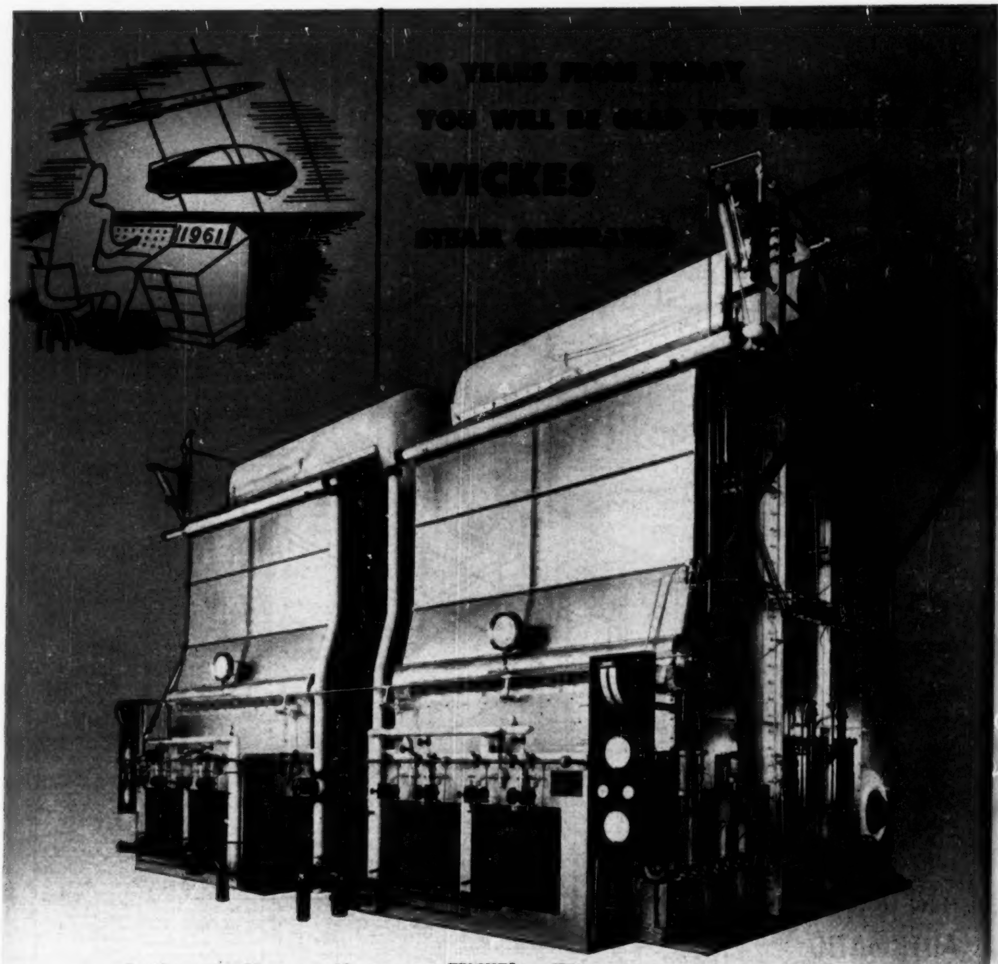
1961
WICKES

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These announcements are obtained mostly from advertisers in MECHANICAL ENGINEERING and ASME MECHANICAL CATALOG

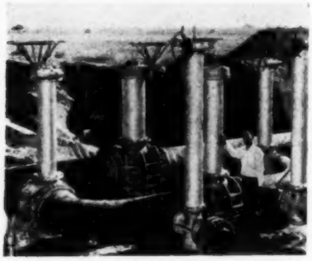
• NEW EQUIPMENT
• BUSINESS CHANGES
• LATEST CATALOGS

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

Underground Valve Installation

This unusual underground installation of Rockwell-built Nordstrom valves with elevated gearing is one of seven such arrangements on the newly operating 501-mile high-pressure natural-gas transmission line of the



Pacific Gas & Electric Co. between Topock, Ariz., and Milpitas, Calif. This photo is of a pressure-limiting station near Bakersfield. Pipe sizes shown are 12, 24, and 34 in. The line, running through deserts, mountains, and rich farmlands will, by Jan. 1, 1952, deliver 400,000,000 cu ft daily to Central and Northern California.

Revolving Joint

A new revolving joint with rotating syphon has been introduced by Rotherm Engineering Co., Inc., Chicago, Ill. Rotation takes place on the flat face of a carbon disk. The opposite side has a ball seat; this ball seat assumes a position correcting the roll eccentricity and piping misalignment.

The floating gland inside of the casing is sealed from leakage around the back by a spring-seated teflon wedge. This joint is also manufactured with a stationary syphon. These joints are capable of handling 150 lb of steam pressure at a temperature range of −200 to +500 F. One of the advantages of this joint is that if the rotating sleeve thread and the syphon pipe thread do not line up, the sleeve thread will assume a neutral position when screwed in the roll.

When the rotating syphon is used it is supported by a carbon bushing that can easily be removed if necessary without removing the joint from the roll.

Overhung Conveyer Drive

Considerable savings in the installation and maintenance costs of heavy belt conveyers are possible with a new conveyer drive developed by the National Iron Co., Duluth, Minn. The new drive uses an overhung driving pulley, eliminating the conventional head shaft and its bearings, as well as the low-speed coupling or chain drive. This eliminates maintenance on head shaft bearings and the low-speed coupling. The latter has been one of the major sources of belt conveyer shutdowns.

National's design uses a special speed reducer built by Westinghouse Electric Corp. It is equipped with an extra-large gear shaft and special antifriction bearings, to provide the extra capacity necessary for overhanging the driving pulley. Taper-hardened gearing and pinion shafts, plus fabricated steel housings, make possible a unit of minimum size and weight.

The first overhung conveyer using this drive has been installed on the Iron Range, at a net saving of over $8000 in installation cost alone. It is believed to be the first installation of such a conveyer to be made anywhere.

Motor Selection and Application

A new educational program designed to aid in the rapid training of industrial personnel in the selection and application of modern electric motor drives has been announced by the General Electric Co.

Fifteenth in the company's "More Power to America" series, the motor program is devoted to the task of quickly indoctrinating qualified personnel in the nation's factories as an aid to industrial mobilization.

The industrial motor program consists of a Motor Selection and Application Course made up of nine 35-mm black-and-white slide films, student review booklets on each lesson, and an instructor's manual. Each film has a running time from 15 to 30 min, and is accompanied by a 16-in. sound recording of the script.

The student booklets are intended to be passed out for home review to those taking the course. They contain reprints of slide film scripts with key pictures, quick-review outlines, and sets of test questions.

Prepared to enable any competent engineer to teach the course, the 96-page instructor's manual includes complete instructions on how to plan and set up each lesson, projection information, and complete scripts and pictures for all nine slide films. It also contains questions and answers to accompany review frames attached to each film, reference sources, and answers to questions contained in the student review booklets.

The entire kit, consisting of the nine slide films, one instructor's manual, and ten copies each of the nine student booklets, is packaged in a luggage-type carrying case, and may be purchased from General Electric for $100. Additional manuals and student booklets are available at nominal cost.

The Motor Selection and Application Course is designed to show how to select the right motor for any job. Specifically, it instructs by showing how motors operate, what types are available, and how to select and apply the right motor from these types.

Palletless Clamp Device

A clamp device described as an "extra-heavy duty clamp," for handling heavy bulky loads without use of pallets, is announced by Clark Equipment Co., Battle Creek, Mich., for use on Clark Utilitruc models, both gas and electric powered with capacities up to 7000 lb, and on the Clark Yardlift-60, gas-powered pneumatic-tired 6000-lb model. The device is similar in design and construction to the standard heavy-duty clamp developed by Clark, except that it is more ruggedly built with heavier slide arms and guides to permit increased arm travel.

The clamp is hydraulically actuated. The slide arms and guides are made from rolled channel sections of alloy steel. Separate double-acting hydraulic cylinders with piston rods actuate each clamp arm for extension and clamping. An auxiliary valve controls the clamp, and a check valve is incorporated in the hydraulic system as standard equipment to prevent loss of clamping pressure.

Clamp arms can be extended from a minimum opening of 24 in. to a maximum opening of 95 in. Over-all width of the clamp assembly with arms closed is 67 in.

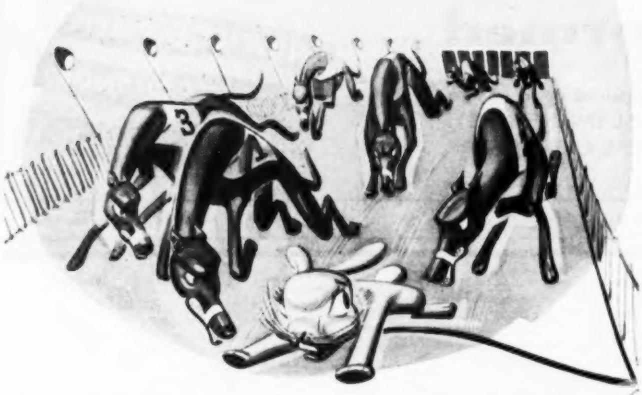
The extra-heavy duty clamp is not detachable; it is mounted on the lift brackets of the truck and cannot be used interchangeably with standard forks. Clamp arms, however, are bolted to the slide arms making them detachable and interchangeable with different types of arms. Forks which can be bolted to the slide arms are available. Rear corners of the slide arms are rounded to prevent snagging when the arms are extended.

No Frost System

The Niagara Blower Co., New York, N. Y., has introduced new, improved "No Frost" equipment for refrigerating cold-test rooms, cold processing, such as the quick freezing of foods, and for food products chilling and cold storage.

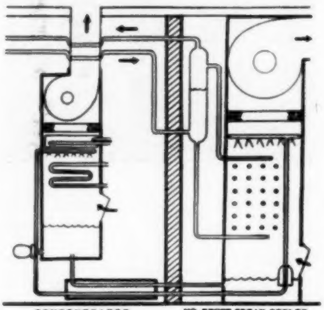
The equipment consists of the Niagara spray cooler which provides a controlled cold

Continued on Page 40



• Keep Informed

air stream at subzero temperatures by means of passing air over refrigerated coils that are prevented from accumulating ice or frost by a constant spray of Niagara No Frost liquid, a nonfreezing compound. In order to keep this process automatic and continuous, the nonfreezing liquid is maintained in a concentrated condition by constantly removing the moisture that is condensed out of the atmosphere by contact with the refrigerated spray. This is done in the No Frost concentrator. A portion of the No Frost solution, as it is continuously being diluted by the condensation of water vapor in the spray cooler is pumped to the concentrator. Here the water is removed by evaporation. The diluted solution is sprayed in a chamber through which air is drawn by fans. A heating element raises the temperature of the air, promoting the evaporation of the water, which evaporates at a much higher rate than the No Frost liquid by reason of vapor pressure differences. In a second stage of reconcentration, located above the spray nozzles, the air stream, which now contains the evaporated water vapor and some No Frost liquid vapor, is cooled by a reflux coil. This, by increasing the relative humidity of the air stream, forces the condensation of the No Frost liquid vapor. The reconcentrated No Frost solution is returned to the spray cooler.



The new concentrator replaces older types in which the water was removed by heating above the boiling point. It has the advantages of operating at lower temperature, increased capacity in smaller space with more compact equipment, easier maintenance, easier and more trustworthy operation with less attention and shutdown time for cleaning. The equipment permits refrigeration to temperatures as low as −30 F without interruption for defrosting. From this point additional refrigerant coils may be used to obtain extreme low temperatures. There is no loss of effectiveness that is common to all refrigeration systems where frost progressively accumulates on refrigerant coils. The new concentrators will be manufactured in a wide range of sizes with water evaporating capacities ranging from $^1/_2$ to 75 gph. A single large concentrator will serve a battery of several large spray coolers.

Oil Reclaimers

Hilliard Corp., Elmira, N. Y., announces a new line of Hilco oil reclaimers. The new line of units features improved design including rotary-type pumps, high-capacity regenerative heat exchanger, new vacuum-pump lubricating system, and general rearrangement for ease of servicing and longer equipment life. Now in production and in service the redesigned units have been giving

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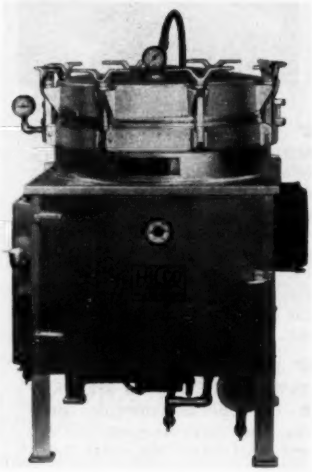
good performance. Hilco oil reclaimers are being used in Diesel and gas engines and compressors, vacuum-pump lubricating and sealing oils, hydraulic oils and industrial oils, and, in fact, any oil that becomes dirty and requires complete purification for continued use. They save large quantities of oil and by keeping oils clean, the result is fewer shutdowns and longer equipment life.



The process consists of first filtering oil through a bed of Hilite-fuller's earth for straight-run mineral oils or Adstay Filter for heavy-duty detergent-type oils. After filtering, the oil flows into a vaporizer where all traces of water, moisture, and fuel dilution are removed and then the oil passes through the high-capacity regenerative heat exchanger where heat is transferred to the cold incoming oil. The vapors resulting from the condensation of water and fuel dilution pass into a distillate receiving tank. These units are continuous and automatic in operation and are available in capacities ranging from 2 gal up to 500 gph.

Reciprocating Refrigeration Machines

Two models of reciprocating refrigeration machines specifically designed for air conditioning and refrigeration use in the 100 to 150-hp range are announced by Carrier Corp., Syracuse, N. Y. After having been thoroughly field-tested, the machines are now being produced in quantity.

The reciprocating machine—designated as the Carrier 30B—is furnished as a complete package with compressor, cooler, and condenser, and all interconnecting piping, fittings, safety and capacity controls, gage board, and cooler and condenser stands included. Careful pre-engineering has assured precise matching of components for maximum operating efficiency and economy. Unusual compactness of assembly, provided through special design of pipes and fittings, reduces pressure loss to a minimum, guarantees better over-all performance, and permits a wide range of applications where space is critical. The machine is particularly suitable for chilling water for air-conditioning purposes, and is readily adaptable to many industrial requirements,

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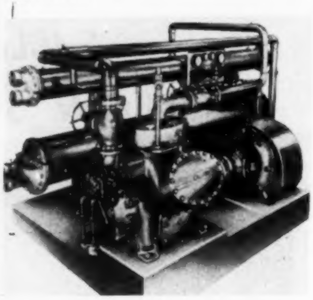
including direct product cooling, brine chilling, and ammonia and chlorine condensing.

The heavy-duty reciprocating compressors used in 30B models are part of Carrier's standard list of reciprocating units. This list includes compressors ranging in size from 3 to 200 hp. Four and six-cylinder compressors of the type built into the new machines may be obtained as separate units for use with either Freon, ammonia, or Carrene 7 refrigerants in 75-hp to 200-hp applications.



Other Carrier reciprocating compressors now available include 2, 3, 4, 6, and 8-cyl models for use with Freon over a range of 3 to 60 hp. The 4, 6, and 8-cyl models may be obtained in various duplex combinations in 60 to 125-hp sizes. Similar models in 4, 6, and 8-cyl compressors are being produced for use with ammonia in the 5 to 50-hp range.

The Carrier list also includes a line of fractional horsepower hermetic compressors. A new line of hermetic condensing units of 3, 5, and $7^1/_2$-hp is being made available this year on defense orders only.

Platform Beam Scale

A new platform beam scale designed for fast accurate low-cost industrial weighing applications has been announced by The Yale & Towne Mfg. Co., Philadelphia Div., Philadelphia, Pa.

Called the Load King, the new Yale scale is designed primarily for heavy-duty industrial applications where "shock-loading" is the rule. The lever system in the platform is all steel as are other key parts. No wood is used throughout.

Poises on the main bar are mounted on roller bearings for rapid positioning. Other features of the new scale include a 100 per cent end-loading platform that gives the same reading regardless of the location of the load on the platform. The platform, which is mounted on outboard bearings also absorbs the shock of moving loads without damage to the scale. It will not tip.

Pit requirements for the Load King are only 11 in., saving considerable expenditure on excavation when the scale is installed. Available in self-contained and semiself-contained models, the new scale is built in capacities up to 6400 lb. Platforms for the new scale range from 46 × 38 to 76 × 54 in.

Ultrasonic Generator

High frequency sound waves are proving to be a useful tool for research and for industry. Scientists find them useful for mixing such naturally insoluble substances as oil and water, or mercury and water. Industrialists find them useful for nondestructive testing of metal castings, and concrete

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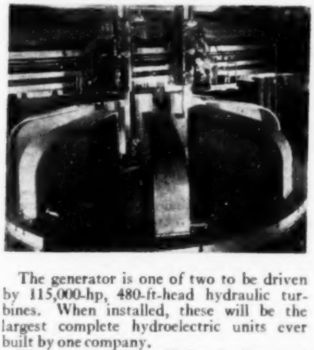
structures; and for mixing paint pigments. Scientists see a future for ultrasonics for improving clothes washers, for agglomerating smoke particles, for pasteurizing milk, for sterilizing containers, and for many other uses.

Scientists at the Westinghouse Research Laboratories are making a study of the fundamental properties of these waves. They feel these studies will lead to new uses for them. The source of these waves is an ultrasonic generator.

The jar of oil atop the generator contains the heart of the device; a tiny quartz crystal. The application of an electronically generated, high electrical voltage across the crystal causes it to vibrate hundreds of thousands of times a second—about 750 thousand. These vibrations create ultrasonic waves; the ultrasonic waves agitate the molecules in the liquid and, if continued long enough, complete mixing or emulsification takes place.

40-Ft Boring Mill

Radial arms of the upper bearing and thrust bearing support for an 82,500-kva, 100 per cent pf, 180-rpm, suspended-type vertical synchronous generator for Hoover Dam are shown being machined on a 40-ft boring mill in Allis-Chalmers shops.



The generator is one of two to be driven by 115,000-hp, 480-ft-head hydraulic turbines. When installed, these will be the largest complete hydroelectric units ever built by one company.

The two turbines will be duplicates of seven previous units built by Allis-Chalmers for this same installation except that the spiral casing sections are of welded plate steel construction instead of cast steel as was used in the original units.

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Worm and Gear-Operated Valves

Worm and gear-operated valves have been added to the line of Homestead-Reiser lubricated plug valves, as manufactured by Homestead Valve Mfg. Co.

The new valves have the patented "Self-Seald" construction characteristic of all Homestead-Reiser valves: port area equivalent to 100 per cent of the area of standard pipe; are cast in semisteel; and made in 8, 10, and 12-in. sizes.

According to the company, these valves will soon be available also in cast-steel, full-port-type, and in venturi type sizes up to 14 in. In the venturi-type these valves will have face-to-face dimensions identical to those of like-sized series 15 wedge gate valves. Full details may be had by requesting Reference Book 39-5 from Homestead Valve Mfg. Co., P. O. Box 550, Coraopolis, Pa.

Silicones

Silicones will make a valuable contribution to America's rearmament program because of their excellent production-increasing and product-improving properties, said J. W. Raynolds, assistant manager of the Chemicals Division of General Electric's Chemical Department, recently.

Silicones resist heat and cold, keep things from sticking, produce useful surface characteristics, and resist chemical attack.

In manufacturing processes, or in products where high or low temperatures are involved, silicones can be a big help. A new G-E silicone rubber retains its resiliency over a temperature range of from 550 F to −85 F. High-speed military planes now being built are incorporating silicone rubber parts because of the greater assurance of positive gasketing action over a wide range of operating temperatures and atmospheric conditions. Silicone oil is another good example of this high-low temperature property. At the

temperature of boiling water, the viscosity of silicone oil is reduced 50 per cent, but that of petroleum oil is reduced 90 per cent; and at 10 below zero, the viscosity of silicone oil increases 300 per cent, while petroleum oil increases over 30,000 per cent. Silicone electrical insulation, because of its high-temperature resistance, permits greater efficiency of motors and transformers, and silicone paints that withstand temperatures up to 750 F have been formulated.

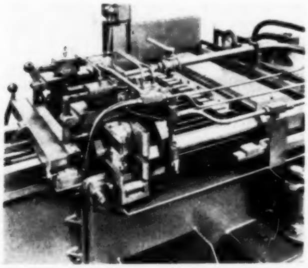
Silicones can also aid manufacturers who have a sticking problem in their business by serving as an agent for releasing such materials as rubber, food, plastics, and cloth from contacting surfaces. Silicone emulsions, greases, and oils, because of their chemical inertness, high-temperature resistance, and low surface tension, help manufacturers cut reject losses and speed production. They are now being used to release rubber and plastics from molds, metal from metal, bread from baking pans, and to safeguard ceramic insulators from contaminating materials.

The unusual surface characteristics of silicones are being put to use in automobile waxes and polishes. It has been found that with proper formulation, silicone oils give car polishes ease of application, improved water repellency, and elimination of rainbow streaking.

One of the most valuable characteristics of silicones is their relative chemical inertness. Silicone fluids will not react with metals. Unlike organic materials, the methyl silicones have no carbon-to-carbon bonds which easily oxidize.

Broaching Valve Guide Bushings

Twelve valve guide bushings, previously pressed into a six-cylinder truck engine head simultaneously on an Oilgear 25-ton two-column vertical pushemall press, are broached simultaneously on this special Oilgear 16-ton horizontal broaching machine. Features include: selector switch for semicycle or manual control, fully interlocked cycle to protect tools and work, conveyer height design, variable broaching and return speeds, hydraulic clamping and group handling of tools.



For the semicycle, operator moves block from conveyer into fixture against a positive stop, left-hand lever is moved to insert locating pins and actuate valves to clamp head hydraulically, right-hand lever is moved to thread the 12 tool shanks through head and into pullers, a pushbutton is depressed to start broaching stroke (pullers grip tools automatically), limit switch stops crosshead when tools leave work, left-hand lever is moved to remove locating pins and unclamp head, center lever is moved to lower positive stop, head is pushed out of fixture onto conveyer, a pushbutton is

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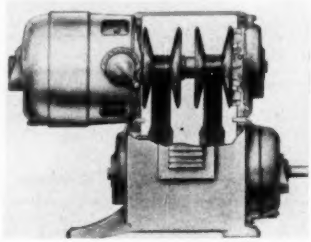
depressed to return tools and insert them into detent holders, right-hand lever is actuated to pull tools outward to clear fixture, center lever is moved to raise positive stop and machine is ready to receive another engine head. Approximately 0.010-in. stock is removed. Peak capacity is 48,000 lb pull; stroke, adjustable, 6 to 15 in.; broaching speed, 30 fpm; return speed, 25 fpm; fluid power is supplied by an Oilgear DX-3511 two-way variable-delivery pump direct-connected to a 25-hp electric motor. Net weight 8060 lb.

Dual Belt Variable-Speed Motor

A line of extra-heavy duty motors for variable speed with ratings as high as 50 hp has been developed by U. S. Electrical Motors, Inc., Los Angeles, Calif. These are part of the company's Varidrive line. To carry the heavy load through the internal speed-changing transmission, U. S. engineers have incorporated dual varibelts, thus distributing the load so that no undue strain is imposed.



To counterbalance belt load, tension control known as Autotaut has been designed. This principle avoids the disadvantages of variable center drives or extra flexing of belts over idlers. A calibrated spring is employed to maintain pressure between the two halves of the driven varidisks and the sides of the belt. The spring takes up any slack that might be caused by stretch or wear of the belts. Use of dual belts does not affect the ease of changing motor speeds which is accomplished by merely turning a control dial.

Totally Enclosed Explosionproof Mining Motors

New totally-enclosed, explosion proof d-c Life-Line mining motors, either nonventilated or fan-cooled, are available from Westinghouse Electric Corp., Pittsburgh, Pa.

These motors conform to designs approved by the U. S. Bureau of Mines for use in gassy and dusty mines. They will withstand an internal explosion, and will not ignite an explosive mixture outside the motor.

Motor data are as follows: 1/2 to 20 hp, 203–365 frames, 55 C temperature limit, 230, 250, 500, 550 volts, series, shunt, or compound windings, 850 to 3500 rpm.

These motors feature all-steel construction, with one-piece rolled-steel frames. Prelubricated, double-sealed ball bearings provide effective lubrication without attention for the life of the bearing. All field and armature windings are thoroughly impregnated in thermoset varnish for additional protection against conditions of extreme moisture. The power cable is brought out through packing glands. Rotating flame seals at each bearing, long rabbet

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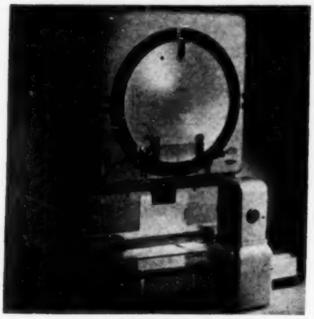
fit between frame and brackets, and screw-type brass access covers assure explosion-proof construction.

Optical Gaging Projector

An inexpensive new projector designed to introduce optical gaging methods into production assembly and inspection was unveiled by the Eastman Kodak Co., Rochester, N. Y.

By projecting a greatly enlarged shadow or a surface reflection of any object placed in its staging field onto a large and well-illuminated screen the machine, Kodak Contour Projector, Model 3, permits instant visual checking of the actual part against detailed drawings or other specification data previously placed over the viewing screen.



The unit is specifically for use "on the line." Heretofore machines of this type have been used almost exclusively in the tool room.

Application of this machine to production and inspection purposes has been made possible by reducing the over-all size of the unit, and by a unique optical system which allows a full unvarying eight inches of space between lens and object for all magnifications up to 100×. This permits use of high-production staging fixtures that automatically key projected objects to a tolerance chart which may be accurately positioned over the projection screen.

The projector body, the work table, and the lamp house can all be separated for attachment to large fixtures used in optical gaging of very large equipment.

Like the earlier version, the new Kodak Contour Projector, Model 3, has an accessory by which light can be sent out of the same lens that picks up the image so that surfaces and deep recesses which cannot be shadow projected may be examined. Either surface or shadow projection is possible for objects facing toward the lens, up, down, to the left, or to the right.

Standardized Gears

Boston Gear Works, Quincy, Mass., announces standardized, stock spur gears and steel miter gears cut to 20-deg pressure angle instead of the usual $14^1/_2$-deg pressure angle. The increased pressure angle permits a wider tooth base, stronger tooth, longer contact surface, larger tooth-bearing surface, and smoother rolling action. Undercut is minimized. The result is increased horsepower per dollar—an average saving of 20 per cent per horsepower delivered as compared with $14^1/_2$-deg gears.

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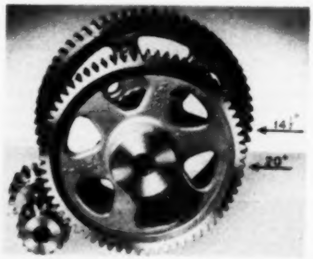
The 20-deg Boston gears of finer pitch may be used for equal work, with a resulting space saving of approximately 20 per cent. Gear weight is similarly reduced, the average increase in hp per lb of gear weight being likewise on the order of 20 per cent for the 20-deg angle gears.

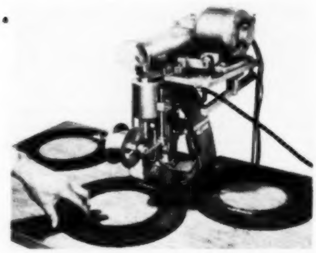


Use of gears of finer pitch for equivalent service also results in a saving in first cost of around 20 per cent.

In addition to these savings the 20-deg pressure-angle gears run smoother and quieter than the 14½-deg gears for the same service.

Numbering Machine

A new machine to trade-mark or number automotive gaskets has been developed by Acromark Co., Elizabeth, N. J. This machine is designated as Model No. EMS, is motor-driven, and utilizes a 43-rpm gear reduction motor for 110–220 volts, a c. A cartridge-type heating element using the same current provides the heat for the die head that carries interchangeable dies or a hot stamping numbering head.



A foot-operated clutch gives the operator full control of the stamping operation which may be up to 43 marked parts per minute depending upon the operator's efficiency and size of the disks or parts being marked.

Actual marking is accomplished by the specially engraved alloy tool steel die applying approximately 2½ tons of pressure under heat, against the pigment color transfer tape pressed against the brake lining or other material being marked. Machine without worktable stands 12 in. wide × 15 in. high × 15 in. deep.

Circuit Breaker Reclosing Relay

A new reclosing relay (type ACR), specifically designed for use on automatic reclosing equipments with all types of power circuit breakers, has been announced by the Switchgear Divisions of the General Electric Co.

The completely automatic reclosing equipments protect feeders against unnecessary

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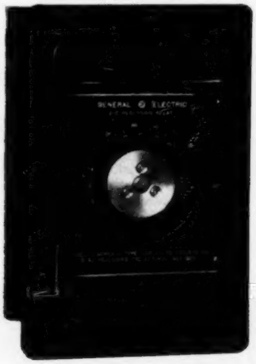
outages due to temporary faults, by automatically restoring service.

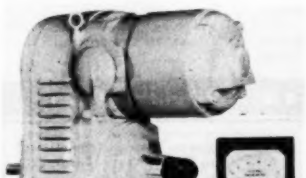
Features of the new relay, not available in previous designs are: optional automatic reset at a definite time after any successful reclosure attempt; a self-contained means for permitting instantaneous initial and time-delay subsequent breaker tripping, and faster immediate reclosure.



The ACR relay may be adjusted for one, two, or three delayed reclosures in addition to the immediate reclosure. The delayed reclosures occur at 15-sec minimum intervals. By adjustment of the cams, longer intervals can be obtained; or the definite-time reset after immediate reclosure attempts can be omitted, in which case delayed-reclosure intervals as short as 5 sec can be obtained. The connections of the relay can be easily changed to omit the immediate initial reclosure.

Variable-Speed Electric Tachometer

For motor applications that require continuous and accurate speed indication, an electric tachometer arrangement has been provided by U. S. Electrical Motors, Inc., Los Angeles, Calif. U. S. Varidrive motors are now available with Model R-1 tachometer and generator in ratings from $1/4$ to 50 hp and speeds from 2 to 10,000 rpm.



The sturdily built, permanently lubricated, ball-bearing-type generator is coupled to the U. S. Varidrive and requires no other source of power. The tachometer indicator is entirely enclosed to prevent entrance of dust and other foreign particles, and can be mounted at distances up to 300 ft from the Varidrive without affecting accuracy. The indicator dial shows operating speed as a per cent of the Varidrive maximum speed.

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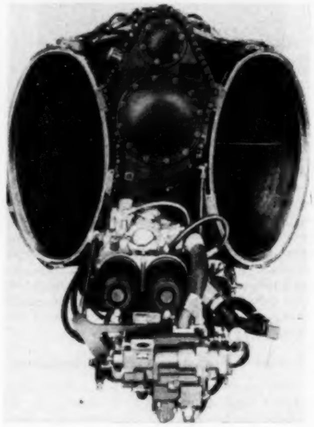
For example, if the Varidrive maximum speed is 1000 rpm and the dial indicates 60 per cent, the Varidrive speed would be 60 per cent of 1000 or 600 rpm. By the use of a percentage indicator, the rate of production of a given machine is instantly available. Other forms of dial indication are also available upon order. Supplied with each unit is 10 ft of two-conductor cable, making possible the mounting of the tachometer in the most advantageous location.

Most Powerful Turbojet

Just released from the Navy secrecy list is this head-on photo of the Westinghouse J-40-WE-6 turbojet aircraft engine, which delivers more thrust than any other jet engine known to be in production today. Manufactured by the Aviation Gas Turbine Division of the Westinghouse Electric Corp. at South Philadelphia, Pa., the engine is slated for installation in the Navy's newest fighter aircraft.



The J-40-WE-6 is completely controlled by an electronic control system that leaves the pilot free for combat duty. The gearbox that drives accessories is mounted snugly between the Y-shaped arms of the split air intake.

The J-40 will substantially increase the combat performance of the nation's carrier air arm, the Navy said.

• BUSINESS CHANGES

Byron Jackson Names Advertising and Sales Promotion Manager

Theodore R. Colville has been assigned the management of all advertising and sales promotional activities for the Byron Jackson Co., Los Angeles, Calif. Mr. Colville will be in charge of the advertising for all four divisions.

Worthington Names Industrial Relations Co-ordinator

Edward Barwell has been named Industrial Relations Co-ordinator of Worthington Pump and Machinery Corp., of Harrison, N. J., to assist Mr. L. C. Ricketts, vice president in charge of manufacturing. In making this announcement recently, Mr. Ricketts said Mr. Barwell would assist him in industrial relations and personnel policies.

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Yale & Towne Appoints General Sales Manager

A. Charles Amann has been appointed general sales manager of the Stamford Division (Conn.) of The Yale & Towne Mfg. Co., succeeding Meade Johnson, it was announced recently. Mr. Amann was formerly industrial sales manager.

Worthington Pump Names Steam Turbine Sales Manager

A. F. Reinking, formerly assistant sales manager, has been named manager of the Steam Turbine Sales Division of Worthington Pump and Machinery Corp., Harrison, N. J., according to a recent announcement. Mr. Reinking will make his headquarters at Worthington's Wellsville plant.

Link-Belt Appoints Chief Engineer

Link-Belt Co. announces that Robert W. Suman has been appointed chief engineer of the company's Philadelphia, Pa., plant. He has been chief engineer for power transmission products since 1946 and is now assuming the added responsibility of materials-handling equipment engineering.

Mr. William S. Campbell, who has been chief engineer at Philadelphia for materials handling and applied engineering products, has retired.

General Electric Announces New Appointments

L. B. Gezon and O. A. Huntsman have been appointed sales manager and assistant sales manager, respectively, of the Metal-Clad and Switchboard Section of the General Electric Company's Switchgear Divisions at Philadelphia, Pa.

S. Vernon Travis has been named assistant general sales manager of General Electric's Large Apparatus Division at Schenectady, N. Y. He is succeeded in his former position as manager of sales for the company's Large Motor and Generator Divisions by Louis H. Matthes.

Appointment of four new managers to positions in General Electric's rapidly expanding turbojet engine plant, Lockland, Ohio, are as follows: George L. Zimmerman, manager of assembly division; Paul Nichols, manager of development manufacturing division; A. W. Jacobsen, manager of the parts division; and Marc A. DeFerranti, manager of facilities for the Lockland plant.

Supervisory appointments in General Electric's Large Motor and Generator Manufacturing Division at Fort Wayne, Ind., have been made recently. F. M. Metrailer has been named assistant to the manager of manufacturing in charge of factory operations and Fenton E. West has been appointed supervisor of methods, planning, and wage rates. The appointments of G. M. Murray as purchasing agent, W. R. David as production supervisor, and P. E. Bohn as staff assistant on special assignments were also revealed.

C. B. Seelig has been appointed assistant manager of the Fitchburg (Mass.) Turbine Sales Division of the General Electric Turbine Divisions.

Gordon E. Walter has been named assistant division engineer of General Electric's Specialty Transformer Engineering Division at Fort Wayne, Ind.

The appointment of Carl W. Moeller as assistant to the manager of engineering of General Electric's Fractional Horsepower Motor Divisions at Fort Wayne, Ind., was also made recently.

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Westinghouse Air Brake Co. Announces Personnel Changes

The appointment of A. J. Bent as director, Industrial Products Division, has been announced by Westinghouse Air Brake Co., Wilmerding, Pa. Mr. Bent, formerly field sales manager of the Division, will direct manufacturing, sales, and marketing activities of the company's air compressors and pneumatic controls in the automotive, marine, oil rig, aircraft, and industrial fields. H. W. McCracken, formerly District Representative in New York, succeeds to Mr. Bent's former position as field sales manager, with headquarters at Wilmerding, and E. W. Kidd, formerly representative in the Boston office assumes charge, with the same title, of the Eastern District in New York. Mr. Bent's headquarters will be in Wilmerding, Pa.

Dresser Industries Elects Officers

The election of Hector P. Boncher, general manager, Dresser Mfg. Div., one of ten operating companies of Dresser Industries, Inc., Dallas, Texas, as a vice president of Dresser Industries, Inc., was announced recently.

Other officers of Dresser re-elected were H. N. Mallon, president; J. B. O'Connor, executive vice president; R. E. Reimer, vice president, secretary, and treasurer; C. Paul Clark, vice president; Arthur R. Weis, vice president; M. H. Nelson, assistant secretary and assistant treasurer.

B & W Tube Co. Makes Changes in Top Officers

The Babcock & Wilcox Tube Co. announced four changes in top executive officers. Luke E. Sawyer, formerly executive vice president was elected president; Alfred Iddles, formerly president was elected chairman of the board; Isaac Harter, formerly chairman was named a consultant to the company; and Edward A. Livingstone, vice president assigned to sales was given broader organizational responsibilities.

Arrowhead Rubber Co. Leases Building

Arrowhead Rubber Co., a subsidiary of National Motor Bearing Co., Inc., at Downey, Calif., has taken a five-year lease on the building at 2350 Curry Ave., Long Beach, Calif., and will transfer its aircraft duct division there shortly.

Acquisition of the new lease will add 27,000 sq ft of manufacturing area, more than triple the space now occupied by the aircraft duct division, and will release valuable space for use in the manufacture of oil seal parts and silicone rubber products.

G.E. to Start Construction on Extension to Turbine Plant

A major addition to General Electric's Schenectady, N. Y., turbine plant will be built in a move aimed at boosting the factory's annual output of fuel-fired generating capacity by more than 1,250,000 kw.

The extension will add more than 80,000 sq ft to the million-square-foot structure.

Total estimated cost for the extension, new equipment, and rearranging facilities will be approximately $6,500,000.

The increased facilities will enable the Company to substantially increase its output of power-producing machinery to meet the National Defense Program's stepped-up demands for electricity in the current emergency. It will provide for more streamlined production, better materials handling, and better integrated truck-shipping operations.

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Carboloy Appoints District Manager

E. R. Almdale has been appointed Manager of the Michigan District for Carboloy Co., Inc., Detroit, Mich. Mr. Almdale will assume the position recently vacated by P. J. Jensen, who has been called back to duty in the Detroit Ordnance District with the rank of Lieutenant-Colonel.

New Promotions Announced by Aetna

J. J. Rozner, formerly chief engineer and works manager, has been elected vice president in charge of operations of the Aetna Ball and Roller Bearing Co., Chicago, Ill.

J. E. Dillon has been appointed to replace Mr. Rozner as chief engineer, and the position of works manager has been dropped from the Company's executive roster.

Also announced was the appointment of C. E. Poehler as assistant to plant superintendent H. V. Fox.

New Western Gear Works Manufacturing Plant

Plans for a new $2,000,000 gear manufacturing plant to be located at Belmont, Calif., were announced by Thomas J. Bannan president of Western Gear Works, Lynwood.

The plant, to be known as Western Gear Works, Belmont Plant, will occupy a 13-acre site and employ more than 300 people. Its production will be devoted to the manufacture of special gear drives for new land-type vehicles in the army's land-tank program.

Kennametal Acquires Nevada Scheelite Co.

The Nevada Scheelite Co., with mines and mill near Rawhide, Nev., is being transferred by sale of stock to Kennametal Inc., producers of hard carbide metals with metallurgical works and toolmaking shops at Latrobe, Pa.

Steps have been taken to improve the output of this tungsten property. Exploration by core drilling has begun. Additional grinding and flotation facilities will be installed in the mill. It is believed that a 50 per cent increase in output of 60 per cent concentrates can be achieved by these and other actions, thus increasing U. S. supplies of much-needed tungsten. Due to the familiarity of Kennametal Inc., with tungsten mining as well as with the metallurgy and end uses of tungsten in tools when finally refined into saleable form, effective utilization is expected.

Koppers Announces Personnel Changes

Appointment of Cooke Bausman, Jr., as manager of the sales department, Central Staff of Koppers Co., Inc., was announced recently by General Brehon Somervell, chairman and president.

Mr. Bausman joined Koppers in September, 1948, as assistant manager of the sales department and since last November 1 has been acting manager of the department.

Also announced was the appointment of Donald MacArthur as assistant manager of the sales department, central staff of Koppers Co., Inc.

At the same time, appointment of T. H. Cable, was announced as manager of the International Product Sales Section of the Department.

Until the recent sale by Koppers of its blast furnace and coke oven plant at Granite City, Ill., Mr. MacArthur was sales manager for that plant, which was operated by the company's Gas and Coke Div.

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Rockwell Mfg. Co. Appoints Advertising and Sales Promotion Manager

Richard J. Brown has been appointed advertising and sales promotion manager of the Delta Power Tool Division of the Rockwell Mfg. Co., Chicago, Ill. He will assume his new duties at the Milwaukee headquarters of the division.

Allis-Chalmers Norwood Works Organizes New Plant Engineering and Planning Department

John Wiehe and Walter Wenzel have been named heads of a new plant engineering and planning department at Allis-Chalmers Norwood (Ohio) Works.

The new department has been set up under the supervision of J. J. DeWindt, general superintendent, to handle further planning in a modernization program underway at the works. The program includes erection of a new 80 × 210-ft nonferrous foundry building, which is expected to be in operation during the third quarter in 1951, and a new oil storage building.

The Norwood plant manufactures small electric motors and pumps.

Yale & Towne Sells Industrial Scale Business

The sale of its industrial scale business to Detecto Scales, Inc., Brooklyn, N. Y., was announced by Elmer F. Twyman, vice-president-in-charge of the Philadelphia Division of Yale & Towne Manufacturing Co. Effective June 1, 1951, the transaction involves scale patents, equipment, parts, and inventory, but none of the Yale trade-marks, except "Kron."

Mr. Twyman explained that the space, machine hours, and manpower release by the sale of the scale business will be used to relieve the pressure of the defense requirements for Yale industrial trucks and hoists.

Timken Appoints Assistant Advertising Manager

S. T. Salvage, newly appointed advertising manager of the Timken Roller Bearing Co., Canton, Ohio, announces the appointment of Norman H. Peterson as assistant advertising manager.

Mr. Peterson joined the advertising department of the Timken company in June, 1946, and has been serving as a copywriter.

In addition, W. B. Moore, vice president in charge of sales of Timken, announced the appointment of Paul Reeves as director of sales.

Westinghouse Forms Air-Arm Division

Westinghouse Electric Corp. has announced formation of a new Air-Arm Div. and plans for a new plant in Baltimore, Md., which will build equipment to advance aerial warfare "a step closer to the push-button stage."

Walter Evans, Westinghouse vice president, reported the purchase of 75 acres on a corner of the Baltimore Friendship Airport. There, by the year's end, he said, the company will be producing for the Navy and Air Force automatic computers to direct gun and rocket fire, radar and autopilots for fighter planes and guided missiles, and complete airborne armament systems.

The new 400,000-sq-ft plant, which will include offices and an engineering laboratory, is expected to be completed by autumn.

It will employ an estimated 2500 to 3000 people by the end of 1952, according to present plans, with that total reaching 4000 in the event of full mobilization.

• Keep Informed

Consolidated Engineering Corp. Moves to New Quarters

Consolidated Engineering Corp. recently moved into a new ultramodern instrument plant. Their new address is 300 North Sierra Madre Villa, Pasadena 8, Calif.

New SPS Sales Officials

Two promotions in the inside sales force of Standard Pressed Steel Co., Jenkintown, Pa., have been announced by J. Whiting Friel, vice president in charge of sales.

C. W. Hollingsworth, former manager, Unbrako Socket Screw Div., becomes Divisional Sales Manager, heading up the Unbrako Socket Screw, Flexloc Lock-Nut, and Hallowell Steel Collar Div. of the company.

Raymond N. Gruber succeeds Mr. Hollingsworth as manager, Unbrako Socket Screw Div.

Barksdale Moves Into Own Plant

Barksdale Valves, manufacturers of extreme pressure 'Shear-Seal' valves, have recently moved to their own plant at 1566 East Slauson Ave., Los Angeles, Calif.

L. S. Barksdale, president, has announced his resignation as vice-president of the W. R. Whittiker Co., and general manager of the Saval Division, and will now devote his full time to Barksdale Valves.

M. C. Nelson has been promoted from chief engineer to general manager.

In addition to expanded production and more efficient management, customer service should be further improved by a division of Sales territories into four major areas, western, southern, Great Lakes, and New England, with a regional sales manager heading each section.

Allis-Chalmers to Manufacture Aircraft Compressors

The largest subcontract yet signed in the Curtis-Wright Corporation's defense expansion program has been announced—a multimillion dollar order to Allis-Chalmers Mfg. Co., Milwaukee, Wis., for the Wright J65 Sapphire turbojet aircraft engine.

Allis-Chalmers will shortly begin construction of a new plant for the manufacture of compressors for the Wright Sapphire, an engine of 7200 lb thrust which powers the Republic F84F thunder jet fighter.

Wright Aeronautical Corporation's engine division of Curtis-Wright is currently entering a large-scale production of the Sapphire at its plant in Woodridge, N. J.

This new contract requires the building of a new plant to cost in excess of $5,000,000. Final plans were consummated when a delegation of Allis-Chalmers officials negotiated the purchase of approximately 200 acres of land at Terre Haute, Ind. Allis-Chalmers officials announced that approximately 400,000 sq ft of floor space would be available for production in the new building and that construction work would begin immediately. The time necessary to get the plant into full-scale production will depend upon deliveries of steel and other construction materials.

A pilot production line would be set up immediately in temporary quarters at Terre Haute and that the first shipments would be made by December of this year, it was announced.

Approximately 300 employes will be needed for work on this pilot line. When the plant is in full production, it is expected that the employment roll will rise to between 3500 and 4000 persons.

Continued on Page 56

• Keep Informed

New Filter Company

Formation of a new jointly owned company to manufacture a unique air filter, first used by the Atomic Energy Commission to keep radioactive particles out of the atmosphere, was announced by Arthur D. Little, Inc., of Cambridge, Mass., and Carrier Corp. of Syracuse, N. Y.

The new company, known as Cambridge Corp., is headquartered in Syracuse, N. Y., and initial production of the new filter is now underway. The filter was developed by Arthur D. Little, Inc.

It was reported that single filter units can be built to handle 1000 cfm of air at pressures within the capacities of central-station air-conditioning systems. Extensive interest had been shown both by industry, civil defense organizations, and by government agencies, it was pointed out.

The new filter will be particularly useful wherever air must be completely dust-free or sterile, as in the manufacture and assembly of precision devices, or in hospitals, biological laboratories, and pharmaceutical plants.

In tests conducted in connection with atomic-energy developments, it was shown that as many as 20,000 particles of various kinds might be present in a single cubic inch of ordinary atmosphere. Conventional air-cleaning devices reduced this number to between 1000 and 3000. The new filter, however, passed on average only a single particle.

The filtering medium itself is a special soft and feltlike paper containing submicroscopic asbestos fibers which direct the air through such tortuous paths that essentially all of the particles become entangled in the fibers. Large sheets of this paper are folded in accordion fashion and fitted into a frame, thereby providing a large filtering surface in a relatively small space.

• LATEST CATALOGS

Wide Range Oil Burning System

A new bulletin issued by Peabody Engineering Corp., New York, N. Y., describes the Peabody constant differential system for use on oil combustion installations. While much has been written on the subject of oil-air ratios affecting combustion efficiency under varying loads, this bulletin is probably the first ever published with such actual proof as that furnished by the Southern California Edison chart incorporated in this bulletin.

Co-ordinated Protection of Motors

Co-ordinated protection—interlinked protection of circuits, motors, and personnel—is explained in a new 12-page high-voltage combination-starter booklet available from the Westinghouse Electric Corp., Pittsburgh, Pa.

Because practically every 2300/4800-volt power system can produce high currents under short-circuit conditions, the booklet stresses the three-way (interlinked) protection for squirrel-cage, synchronous, wound-rotor, and multispeed motor installations. Three classes of combination motor starters are illustrated: (1) Class 11-252-AH2F air-break combination starter for squirrel-cage induction motors; (2) Class 11-252-OH2F combination starter with oil-immersed contactor; (3) Class 14-252-OH2F combination synchronous motor starter with Slipsyn ® field control. The Type BAL fuse, a component of each starter, is described with illustrations, and graphs and oscillograms show its fault-protecting abilities.

• Keep Informed

Mixflo Pumps

A new Bulletin No. W-313-B1B on Mixflo Pumps for irrigation, drainage, sewage disposal, condenser circulating and low head water supply, is available from Worthington Pump and Machinery Corp., Harrison, N. J. The bulletin includes line drawings and dimensions of Mixflo types M, MA, MC, MD, and MDC in sizes 20 to 84.

Vinylite Surface Coatings

Protective and decorative coatings for all types of surfaces that have shown truly outstanding performances are described in a new 28-page booklet offered by Bakelite Co., a Division of Union Carbide and Carbon Corp., New York, N. Y. The booklet, entitled "The Story of Surface Coatings Based on Vinylite Resins," discusses the many essential applications of these surface coatings and is illustrated with a wide selection of photographs.

From tiny metal closures to huge railroad hoppers and oil tanks which have been afforded excellent protection with the use of these coatings, the booklet emphasizes actual case histories of outstanding performance after years of use.

The booklet also describes the variety of surfaces which can be coated, including metal, paper, cloth, masonry, brick, concrete, and wood, and discusses the various techniques of application such as spraying, brushing, roller and knife coating, and dip coatings to which surface coatings based on these resins are suitable.

Copies of this booklet are available to business executives by sending request to Bakelite Co., Dept. 1503, 300 Madison Ave., New York 17, N. Y.

Mechanical Fastening Methods for Aluminum

Latest addition to the group of technical books published by Reynolds Metals Co. is "Mechanical Fastening Methods for Aluminum." Here are 136 pages of information on the many different ways for mechanically joining aluminum parts, including the use of metal stitching, resin bonding, and ingenious mechanically formed joints. Other joints are made with rivets, screw fasteners, nails, or pins . . . . . all are described in detail, their applications analyzed and advantages pointed out.

The book is divided into eight main sections. These are devoted to (1) standard rivets, (2) special rivets, (3) standard screw fasteners, (4) special screw fasteners, (5) nails and pins, (6) metal stitching, (7) mechanically formed joints, and (8) resin bonding.

In addition to 95 pages of text, there are three indexes, including a condensed table of contents, an index of tabular matter, and an itemized cross index. Some 314 illustrations show how the various fastening systems work and present typical applications.

This 6 × 9-in. pocket-size book is wire-bound to lie flat when opened. It will be sent without charge to engineers, designers, production men and executives in the metal-working industry who request it on company letterhead, to Reynolds Metals Co., Louisville, Ky.

Other technical books on aluminum, its production and fabrication, available from Reynolds include "The A-B-C's of Aluminum," "The Aluminum Data Book," "Designing with Aluminum Extrusions," "Finishes for Aluminum," "Aluminum Structural Design," "Heat Treating Aluminum Alloys," "Machining Aluminum Alloys," and "Welding Aluminum."

Continued on Page 58

• Keep Informed . . .

Thread Inserts

New 16-page two-color bulletin covering design data on helical-wire thread inserts and the use of these inserts in the protection and repair of tapped holes is offered by the Heli-Coil Corp., L. I. C., N. Y.

Detail drawings and text explain how these inserts are used as original manufacturing components to protect tapped threads in aluminum, magnesium, plastics, iron, steel, and wood against stripping, wear, corrosion, seizing, and galling.

Also covered are the uses of these Heli-Coil screw-thread inserts in production salvage operations—to repair threads damaged during the manufacturing process—and in maintenance operations—to repair threads damaged in use.

Tube-Supported Walls

A new 12-page 2-color catalog on tube-supported walls for industrial boilers has just been made available by Bigelow-Liptak Corp., Detroit, Mich. The catalog describes in detail how Bigelow-Liptak walls may be suspended directly from boiler tubes with resulting savings in steel and erection time. Engineering drawings show typical jobs and describe how the enclosure is fastened to the boiler tubes. Of particular interest is a series of photos of a job being erected.

Valve Sizing Charts

A steam valve sizing chart covering the range from 1 to 1,000,000 lb per hr and a butterfly valve sizing chart covering the range of 15 to 10,000 gpm have been published and are available from Fischer & Porter Co., Dept. 3940, Hatboro, Pa.

Potentiometers

A new 36-page catalog covers ElectroniK electric control potentiometers for both contact and proportional control. Engineering and constructional data, types of control, partial list of available ranges, application data, and accessories are described. Catalog 15-15 is available from Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia, Pa.

"X-Y" Type Recorder

Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., announces Bulletin No. 330, four pages, describing and illustrating their new Model MD-2 recorder. The instrument is a portable, self-contained Microformer type which will plot automatically on rectangular co-ordinates any two variables that can actuate the movable cores of miniature variable transformers (Microformers), either directly or through accessory Bourdon tube units.

Blowers

A new publication on the Standardaire blower has been issued by Read Standard Corp., New York, N. Y. It gives dimensional information including (1) engineering layout, (2) typical application data, (3) important design data, (4) blower number, (5) rating—cfm at listed rpm.

Heat Exchangers

Bulletin HE-7, offered by Henry Vogt Machine Co., Louisville, Ky., covers the Vogt-type heat exchangers. Design data and typical uses are included.

Oxy-Acetylene Flames

The contribution that the oxy-acetylene flame has made to the progress of industry is outlined in a new booklet, "Oxy-Acetylene Flames and Metalworking—A Story of Industrial Progress," by Linde Air Products Co., a Division of Union Carbide and Carbon Corp., New York, N. Y. This 16-page illustrated booklet traces the history of the oxy-acetylene flame and explains how industry is using it today in cutting, welding, and heating operations. Many specialized jobs of the flame, such as hard-facing, flame-softening, flame-hardening, powder-cutting, and steel-conditioning, are briefly described.

Steam Trap Problems

A new catalog published by V. D. Anderson Co., Cleveland, Ohio, entitled, "Solving Steam Trap Problems," contains helpful, practical information for engineers who specify steam traps. Contains specifications and capacities on the complete line of Super-Silvertop steam traps, Anderson float traps, air-release valves, and pipe-line strainers. Describes how to calculate condensation loads and select traps for all classes of equipment, including unit heaters, jacketed kettles, autoclaves, submerged surfaces, hospital, kitchen and laundry equipment, steam mains, header drips, and other units.

Portable Air Compressor

Bulletin H-850-B73, issued by the Advertising Extension, Worthington Pump and Machinery Corp., Dunellen, N. J., describes the Blue Brute 160-ft portable air compressor. This bulletin, together with one covering the 105-ft portable air compressor which is forthcoming, shall supercede Bulletin H-850-B69, which covered both the 105 and 160-ft air compressor.

Hydraulic Testing Machines

A new super "L" line of hydraulic testing machines for tension, compression, transverse, and flexure testing is fully described in Bulletin No. 40 now available from Tinius Olsen Testing Machine Co., Willow Grove, Pa. These machines are available with 3 ranges in capacities of 60,000; 120,000; 200,000; 300,000; and 400,000 lb.

Detailed description with illustrations covers the unique electronic Selectorange Indicating System, which provides a 50 to 1 spread of testing ranges on one 28-in. dial; ability to change from any of the three ranges to another during test without changing rate of loading; and an automatically illuminated load range indicator. The electronic indicating system is entirely separate from the loading system.

Also included is description of the new Olsen Electronic Recorder which provides 100 to 1 spread of ranges, and available tools for use with the machines.

Instrument Transformer Buyer's Guide

A profusely illustrated, 93-page brochure, GEA-4626, supplying pertinent buying information on G-E instrument transformers, has been announced as available by the General Electric Co., Schenectady, N. Y.

The publication is divided into sections which offer technical data on indoor and outdoor potential transformers, current transformers, metering outfits, potential and current portable transformers. Listings of ratio and phase-angle tests, coupled with tables covering the mechanical and thermal limits of current transformers, round out the balance of the brochure.

• Keep Informed

pH Measurement

"The Meaning, Application and Measurement of pH" is the title of a new Bulletin No. 28X7636 released by the water conditioning department, of Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Tables reproduced show the different pH values of common acids and alkalies, the intensity of acidity or alkalinity, and the most desirable pH range of industrial waters for different conditions and applications.

Worthite Specialties

A new Bulletin No. W-350-B5C describing valves, flanges, hose nipples, bars, welding electrodes, and screw-machine products may be obtained from Worthington Pump and Machinery Corp., Harrison, N. J.

Single-Acting Nonreturn Valve

A new 6-page Bulletin No. S-2 fully describes the cushioned single-acting nonreturn valve made by Golden-Anderson Valve Specialty Co., Pittsburgh, Pa.

Three different yoke assemblies on the elbow, angle, and globe bodies are featured in detailed drawings, with a complete list of parts. The adaptability, testing, construction, installation, sequence of operation, servicing, and specifications are fully described, along with tables showing general dimensions, approximate shipping weight, and general list of materials.

Multistage Turbines

A new six-page bulletin, featuring Terry GAF and ZAF multistage turbines has been announced by The Terry Steam Turbine Co., Hartford, Conn. The overspeed governor, governor valves, blades, diaphragms, and many other design features are discussed and illustrated.

Hydraulic Press Manufacturing

R. D. Wood Co., Philadelphia, Pa., manufacturers of hydraulic presses and equipment, have recently issued a photographic booklet covering certain of the company's production divisions. Reproduced by sheet-fed gravure in two colors, the 32-page booklet is designed to give an informative picture of some of the 150-year old firm's facilities, methods, and equipment, particularly as they relate to the manufacture of hydraulic presses, valves, and allied equipment.

Single-Feeder Substations

Application of the CSP® power transformer as a completely packaged, single-feeder substation is described in a new 16-page booklet No. B-4692, available from the Westinghouse Electric Corp., Pittsburgh, Pa. Combining the 43 components of a conventional substation into a single unit saves both time and money in planning, installing, maintaining, and moving the equipment.

The CSP power transformer has complete lightning, surge, and fault protection; automatic voltage regulation; load switching; and metering—thereby performing all the functions of a single-circuit substation.

An illustrated discussion is included on the type URS tap changer equipment, the automatic overload and short-circuit protection, the readily accessible instrumentation and instrument transformers, and the De-ion® low-voltage switching.

The CSP power transformer is available in ratings from 300 to 3000 kva at high voltages of 69 kv and below, and low voltages of 1501 to 15,000 volts.

Continued on Page 60

• Keep Informed

20-Kw Induction Heater

An improved electronic-type 20-kw induction heater, featuring a nonventilated, dust-proof, NEMA Type 12 enclosure, has been announced by General Electric Co., Schenectady, N. Y., and is described in Bulletin No. GEA-5594.

For use in high-speed annealing, brazing, hardening, and soldering, the new heater is designed so that only the control and accessories required for a particular heating application need be purchased.

For short-run production of a wide variety of parts, G. E. recommends the Type HM-20L1 heater. This model has variable-power adjustment from 0 to 100 per cent by means of a rheostat, either mounted in the work table, or purchased separately for mounting elsewhere.

For long-run, higher-production applications which do not have rapid cycling, the Type HM-20L2 heater (without variable power adjustment) is recommended. On such applications, the heater is initially set to heat a specific part and no further adjustment is necessary.

The complete heater, in either model weighs approximately 3600 lb. Units are available for operation on 230, 460, or 550-volt, three-phase, 60-cycle power supply.

6000-lb Fork Trucks

Baker Industrial Truck Div. of the Baker-Raulang Co., Cleveland, Ohio, has released a new eight-page specification Bulletin No. 1325 which includes user benefits of the major components of the FT-60 6000-lb-capacity fork truck. The bulletin contains dimension drawings which show the maneuverability of the truck, detailed specifications which permit comparing this truck with other 6000-lb fork trucks, pictures of this truck working in eight different industries and 16 different applications, and other helpful information.

Bearing Manual

SKF Industries, Inc., Philadelphia, Pa., announces that their 270-page book, "Ball and Roller Bearing Engineering," is for the first time being made generally available to engineers, product designers, maintenance men, and engineering students. The text covers in technical detail such subjects as bearing types and nomenclature, capacities, selection, design, installation, maintenance, causes of failures, and load calculations.

SKF is offering copies to interested individuals in the Continental United States only at the special price of $1.75.

Sound Films

Seventy-two sound films that cover general interest subjects, product information, and training and instruction courses are listed in a new 1951 sound-film catalog available from the Westinghouse Electric Corp., Pittsburgh, Pa.

Divided into three sections for easy reference, the catalog provides a page of descriptive text (with illustrations) for each film. Under each title is a list of people the particular film should interest; and film size, projection time, type of film, and shipping weight are given. Typical films are: general interest—"Electrical Proving Ground"; product information—"It's CSP for Me!"; training and instruction courses—"Hints on Electrical Servicing in the Air-Conditioning Industry."

All films are loaned free to organized groups, such as church, social, professional, civic, and business—cost of transportation must be paid by borrower.

• Keep Informed . . .

Hydraulic Metal-Working Presses

American Steel Foundries, Elmes Engineering Div., Cincinnati, Ohio, has issued a 12-page Bulletin No. 1010-B, which illustrates and describes Elmes hydraulic metal-working presses. Electric control provides semiautomatic operation, automatic operation, and inching, with speed change and reversal of slide governed either by ram travel or pressure, which ever is preferable.

Magnetic Protection

The Eriez Mfg. Co., Erie, Pa., has released a new Bulletin No. 702 on the Eriez Magnetic Pump. This unit is designed to remove tramp iron from materials conveyed in pneumatic, gravity flow, or liquid lines. The presence of tramp iron is a hazard to industry, resulting in damage to expensive equipment, costly fires and explosions, and contamination of products.

Magnetic Pumps have proved successful in eliminating tramp iron from processing lines in the textile, metalworking, food, chemical, tobacco, rubber, and many other industries.

Included in the booklet are construction and application data, information on the selection of the proper magnetic separator and engineering diagrams.

Special Size Castings

A folder which describes the specialized round casting service is offered by the Pyott Foundry and Machine Co., Chicago, Ill. According to the company there are but a few foundries in this country equipped to give this service.

Rolling Doors

The 1951 catalog on Kinnear Rolling Doors, manufactured by Kinnear Mfg. Co., Columbus, Ohio, is now available. This contains the most up-to-date details on the interlocking steel-slat rolling door.

Although the steel rolling door is universally preferred, a bulletin on the Kinnear Wood Rolling Door which operates on the same basic principle but which will be available as a substitute in case of armament demands causing a shortage in steel supply, is also available.

Nozzles, Necks, Flanges

The new Taylor Forge Catalog No. 501, which describes and illustrates Taylor forge nozzles, welding necks, and large-diameter flanges is now available from Taylor Forge & Pipe Works, Chicago, Ill. Also included in this catalog are data covering standards of the Tubular Equipment Manufacturers Association (TEMA Standards). The Taylor Forge publication, Modern Flange Design, is also incorporated as a part of this catalog.

Rolled and Welded Steel Products

A circular issued by Cleveland Welding Co., Cleveland, Ohio, illustrates and describes the shapes of rings, bands, hoops, flanges, weldments, and other circular rolled and welded-steel products manufactured by the company. The plant is described including equipment and laboratory facilities. In addition, information is given on various metals handled by the company and their specialization in such items as gear blanks, electric motor shells and frames, truck, tractor, and farm implement rims.

Lubrication

As a producer of molybdenum disulphide for purposes of lubrication, Climax Molybdenum Co., New York, N. Y., has prepared a booklet on the use of molybdenum disulphide as a lubricant. Containing excerpts from technical papers, this publication should prove valuable to those interested in lubricants and antifretting materials.

Recorder-Amplifier

Baldwin-Sanborn direct writing recorder amplifier assembly is described in Bulletin 332, issued by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. This instrument is designed for inkless recording of electrical unbalance of a resistance bridge when using strain sensitive elements such as SR-4 strain gages or temperature-sensitive elements. The bulletin covers performance and operation of amplifier and recorder assemblies, and lists available accessories.

Combustion Safeguard

"Protectoglo Combustion Safeguard for Industrial Gas-Fired and Oil-Fired Burners," Catalog No. 9601, has recently been published by the Minneapolis-Honeywell Regulator Co., Industrial Div., Philadelphia, Pa. This 32-page catalog is actually a complete manual on flame failure protection for industrial applications.

Included in this catalog is information on the new "flame-rectification principle" of operation, descriptions of the many types of system components, installation drawings, bills of material, comprehensive information on 24 different safeguard systems, and an enclosed price list.

BALL bearings are necessarily made to close tolerances which apply not only to the balls and races but also to the retainers which must have exact dimensions and shapes. This matter of retainer quality has been given careful study by the Stephens-Adamson Mfg. Co., Aurora, Illinois, maker of the well-known SealMaster Industrial ball bearing units. The company collaborated closely with the Revere Technical Advisory Service in working out the specifications and forming procedures for its brass retaining rings. As a part of this joint activity, Revere made a full survey of Stephens-Adamson requirements, with the object of standardizing and simplifying specifications for the benefit of both the engineering and the purchasing departments. The success of this work is indicated by this statement from the Superintendent of SealMaster bearing production: "First and foremost, I am pleased with the uniformity of gauge and temper of the Revere brass we have been receiving. This uniformity makes it possible to produce ball retainers of very close tolerance, with a minimum of rejections and at comparatively low unit cost. Furthermore, I have appreciated the dependable delivery service and the cooperation of the Revere organization."

In these times of scarcities, when it is more than ever necessary to reduce waste and save metal, you may wish to take advantage of Revere's skill and know-how in non-ferrous metals. Just get in touch with the nearest Revere Sales Office.

ABOVE, the largest retainer made for a SealMaster industrial ball bearing unit, contrasted with the smallest block and retainer.

BELOW, three of the steps in retainer production: blanked, formed and punched, and assembled part ready to receive the balls.

REVERE 150th year of service to America

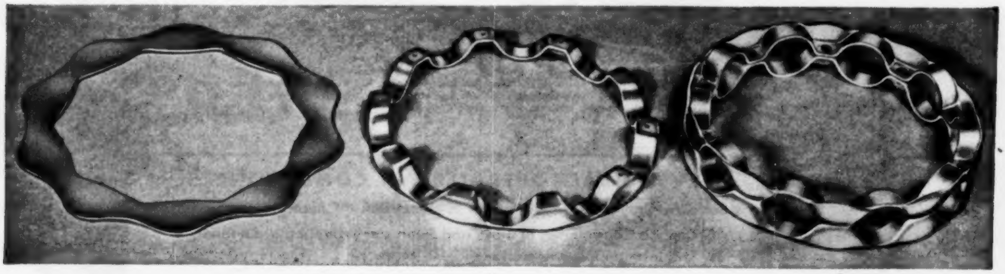
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

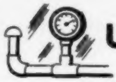
230 Park Avenue, New York 17, N. Y.

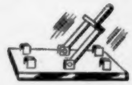
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY



Chiller offers many operating economies


Uses steam from any source, even *waste* steam!

Electric-power needs are nominal



Light enough to install on any floor

Supplies chilled water or air conditioning

YOU'LL find it well worth while to consider the new Servel 25-Ton Water Chiller as a source of chilled water for industrial processing, or air conditioning. It's so light, quiet, and free from vibration you can install it on any floor, even the roof. You can operate it on steam from any source, at any pressure, produced with any fuel. If waste steam or waste heat is available, you can operate on it, and save most of the normal costs of fuel. And since electric-power requirements are negligible, you can usually connect it to existing electric systems.

Along with these installation economies, you get the operating benefits of Servel's famous no-moving-parts cooling system. This means dependable operation, long life, and low maintenance. You get unusually close control of temperatures, too, because you can modulate capacity as much as 50%.

Send today for full information. No obligation. And if you care to include details of your cooling or air-conditioning problem, we'll be glad to have our application engineers make suggestions.

WHY SERVEL IS YOUR BEST AIR-CONDITIONING BUY

• No moving parts in cooling system to wear out • Low maintenance costs • Long life • Hermetically sealed • Complete safety of operation • Chilled-water circuit operates under normal pump pressure

SEND COUPON FOR MORE INFORMATION

Servel

AIR CONDITIONERS

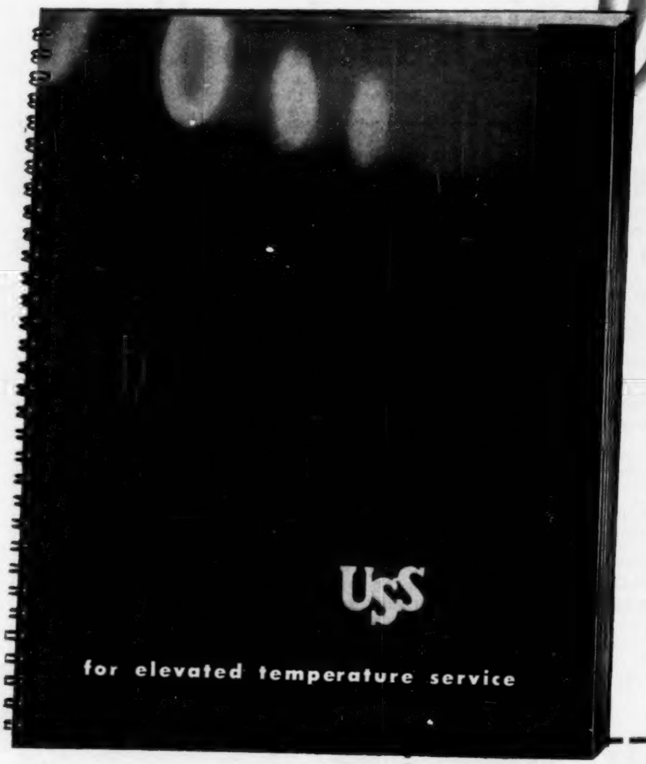
FOR INDUSTRY • FOR HOME • FOR BUSINESS

Servel, Inc.
Department U-27, Evansville 20, Indiana
Gentlemen:
Please send me more information on the following:
Servel 25-Ton Water Chiller________
Servel Self-Contained Air Conditioner________
Servel 3- and 5-Ton *All-Year* Air Conditioners________
*Name*________
*Firm*________
*Address*________

IF YOUR JOB CAN BE DONE BETTER WITH AIR CONDITIONING OR COOLING, IT CAN BE DONE BEST WITH SERVEL

"Steels for elevated temperature service"

An authoritative book on this important subject . . . *yours for the asking!*



This book is the result of 15 years' study of high temperature problems by United States Steel Corporation and its manufacturing subsidiaries.

It is designed to be helpful to engineers, metallurgists and chemists in their quest for suitable structural materials that will maintain adequate strength under the elevated temperatures involved in the power, petroleum, transportation, chemical, and other industries having similar problems.

In its pages are discussed the general principles of behavior of ferrous materials under elevated temperatures, the various factors that influence this behavior, as well as the special testing equipment and laboratory technique used to evaluate the elevated temperature properties of steel.

In the comprehensive data section, the significant property values of *twenty-one* different steels, suitable for use at elevated temperatures, are presented both in tabular and graphical form. Characteristics such as high temperature strength, corrosion resistance, weldability and others are discussed.

Much of the information in this book has never before been published. You'll find it invaluable as a reference if your work involves the operation of equipment that must function at elevated temperature. Use the coupon.

United States Steel Corporation Subsidiaries
Room 4269, 525 William Penn Place

☐ Please send me the new book, "Steels for Elevated Temperature Service."

☐ Please have a representative call on me.

Name.................................Position.........................

Company..............................Address.........................

City.................................Zone.....State...................

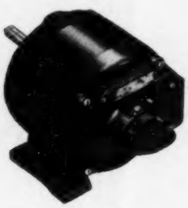
UNITED STATES STEEL COMPANY, PITTSBURGH
COLUMBIA STEEL COMPANY, SAN FRANCISCO
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

UNITED STATES STEEL

Digest — G-E PRODUCT HIGHLIGHTS

A FULL LINE OF FHP MOTORS TO MEET YOUR NEEDS



Fhp machine-tool motor

This polyphase induction motor, specifically designed for frequent start-stop duty on machine tools, is one of a wide variety of G-E standardized fractional-hp motors available to meet your design needs. This complete line includes, for general applications, polyphase induction, d-c, capacitor-start, and split-phase motors, as well as gear and unit-bearing motors and a broad selection of definite-purpose motors for more limited applications. Specify one of these G-E motors in your next design. They're known to be preferred by your customers, play a big part in selling your product. See Bulletin GEA-5174.

SPEED, ACCURACY AND FLEXIBILITY —ALL IN ONE!

Photoelectric recorder

Besides measuring a-c and d-c volts and amperes, this versatile General Electric photoelectric recorder provides a quick, accurate record of almost anything that can be measured with an indicating instrument—temperature, speed, pressure, thickness, light, and vibration. In deflection and potentiometer types, for portable use or semi-flush mounting, it features chart speeds from ½ inch to 72 inches per minute, sensitivities as low as 1.0 microampere full scale, and response periods as fast as ⅛ second for full-scale deflection. See Bulletin GEC-254.

HOW TO SIMPLIFY "BUILDING-IN" THE RIGHT SPEEDS

Adjustable-speed manual

This 26-page illustrated manual—a worthwhile addition to your reference file—covers the entire subject of adjustable-speed drives, including their economic and engineering benefits and the points to consider in their selection. Especially helpful is a concise description of available General Electric *packaged* adjustable-speed drives, plus a well-organized table that summarizes the ratings and performance features of each drive. See Bulletin GEA-5334.

NOW—MOTOR SELECTION AND APPLICATION SIMPLIFIED

NEW G-E "SHOW-HOW" COURSE helps train your workers

Of special interest to designers is this new General Electric Motor Selection and Application Course—timed to meet today's need for more motor "know-how" by your personnel. A G-E More Power to America program, it shows simply and clearly how motors work, types now in use, how to select and apply them to specific jobs. Kit includes instructor's manual, nine slidefilms with records, student review booklets, and sturdy carrying case. Ask your G-E representative for a free copy of the manual. Meanwhile send for Bulletin GEA-4938-16 describing the course in detail.

General Electric Company, Section K 668-89
Schenectady 5, N. Y.

Please send me the following bulletins:

☐ for reference purpose
☐ in connection with immediate projects

- ☐ GEA-4938-16 Motor selection and application
- ☐ GEA-5154 A-c magnetic contactors
- ☐ GEA-5174 Fractional-hp motors
- ☐ GEA-5334 Adjustable-speed manual
- ☐ GEC-254 Photoelectric recorder

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Short cuts

worth following in your

In drafting **Costly retracing is eliminated in producing drawings which include standard components.** The functioning of many IBM machines can be changed by adjusting the wiring on the plug-board panels. And in order to give customers a record of the wiring combinations they will use—without retracing the standard panel detail time after time—IBM follows this short cut:

It makes photographic intermediates of its plug-board panel drawings by reproducing them on Kodagraph Autopositive Paper. Then, to these sharp, clean, translucent prints, the draftsmen simply add the various wiring arrangements . . . and "masters" are available—ready to produce the required number of direct-process prints.

How IBM produces Autopositives

It's an easy, economical operation—revolutionary when compared to other methods of producing photographic intermediate prints.

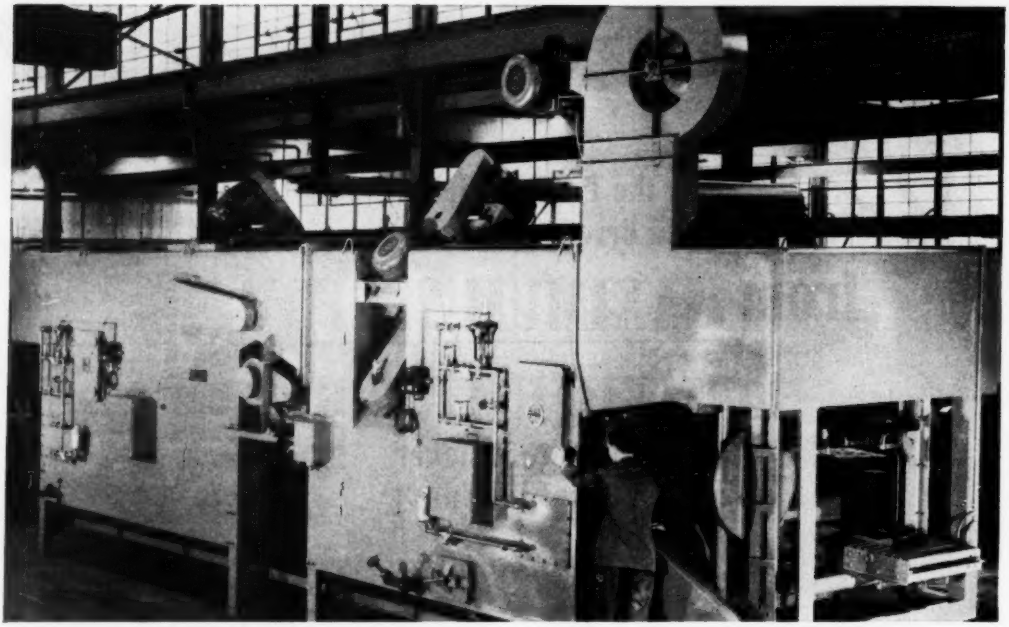
First of all, Kodagraph Autopositive Paper produces positive photographic intermediates directly—without a negative step. Furthermore, it can be *handled* in ordinary room light . . . *exposed* in a direct-process (or blueprint) machine at uniform, practical speeds . . . *processed* in standard photographic solutions. And the result—a sparkling intermediate with dense black photographic lines on a white, durable, translucent paper base.

In copying blueprints

How to get extra copies of blueprints and direct-process prints *quickly and economically* . . . is no problem for IBM. These prints are used to exchange design information between the plants in Endicott and Poughkeepsie, N. Y. Whenever extra copies are needed for the shop, the necessary print-making intermediates are made directly—in both plants—simply by reproducing the blueprints on Kodagraph Autopositive Paper.

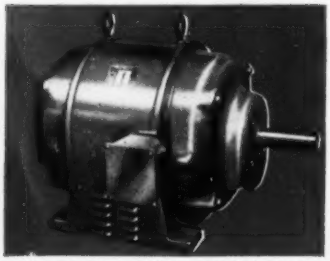
In reclaiming old drawings

Some IBM drawings which show the effects of long service—which are discolored, weak in detail, and slow-printing—are reproduced on Kodagraph Autopositive Film. This high-contrast, direct-printing photographic material (which is handled like Autopositive Paper) cleans up backgrounds . . . intensifies line detail—produces intermediates which have dense black photographic



How to give a cylinder block a clean start

Howell Type K Motor. Offers constant performance in the presence of dirt, dust, fumes and moisture. Sizes 3 to 150 H.P. at 1800 R.P.M. Either vertical or horizontal mounting.



Howell Type F Motor. A high-slip, high-torque motor designed for punching and shearing operations. Sizes ½ to 200 H.P. in open frames; ½ to 125 H.P. in enclosed frames.

This new Centri-Spray washer thoroughly cleans up to 400 cylinder blocks an hour. It often runs 3 shifts a day, six days a week. A tough job for the nine Howell Industrial Motors which power it!

Four 25-H.P. motors operate the unique Centri-Spray units which envelop the rotating blocks with a powerful high-volume spray of water. A high-head centrifugal pump, equipped with a 15-H.P. motor, flushes blocks internally. All foreign matter is *completely removed*, inside and out. Four motors, from 1/3 to 20 H.P., power the automatic sludge remover, the recirculating pump, the main conveyor and the high-pressure blowoff fan.

Howell engineers worked closely with this manufacturer to provide the *right* motor for each application. As a result, this Howell-powered washer easily takes the hardest operating schedule in stride.

Highest quality motors, designed for your specific jobs, are typical of the service you get from Howell. Let us handle your electric motor needs. You'll find precision-built Howell industrial type motors a profitable investment that pays off in extra years of dependable performance.

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HOWELL Red Band MOTORS

HOWELL MOTORS

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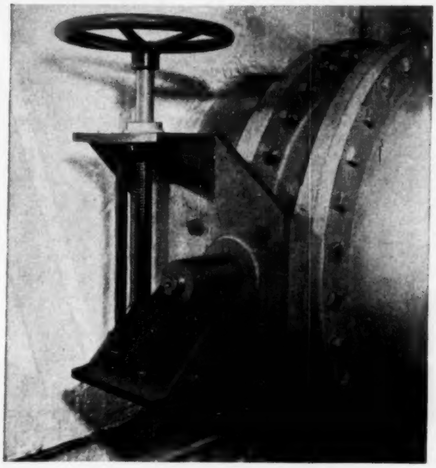
R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



RUGGED
Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
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No. 782—Heavy Duty Rubber Seated Wafer Type Valve with 5° angle seated vane and enclosed gear reduction drive. Gland can be removed and stuffing box repacked without removing prime mover.

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

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No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

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reveals sound
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Radiographic waves search the internal structure of Lunkenheimer steel gate valves, exposing the dense, sound quality of their castings. The smooth tone of this short-wave gamma ray photo is your final assurance of soundness in the steel valve you depend on for round-the-clock service. Other tests guard the Fig. 1751 from imperfections after every manufacturing process — from foundry to final assembly.

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The disc rises clear of the straight-through, streamlined port-to-port flow to minimize turbulence and pressure drop. Backseating faces let you repack the valve while it's wide open and under pressure.

Write for your copy of "Lunkenheimer Cast Steels," a brochure which will help you select the proper steel valves for service under any pressures, temperatures, or operating conditions. Address: The Lunkenheimer Co., Box 360E, Cincinnati 14, Ohio.

Figure 1751
Steel Gate

STEEL • IRON • BRONZE

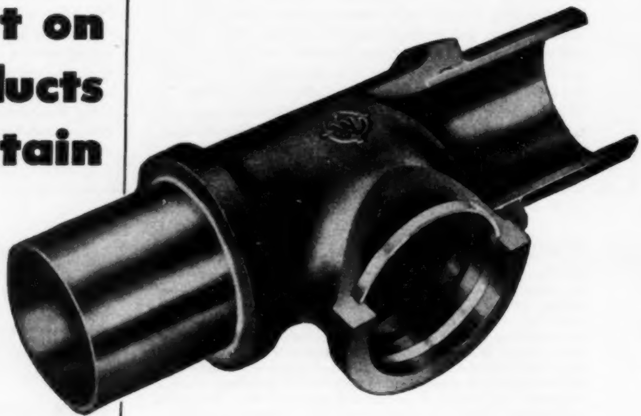
LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-151-37A

DON'T BE SATISFIED WITH HALF-WAY MEASURES...

insist on Walseal® products and be certain



— the FACTORY INSERTED Ring insures FULL PENETRATION of the Silver Alloy . . . a perfect joint

Today, contractors . . . builders . . . architects are using brazed connections, in ever increasing numbers on their brass and copper pipe runs. However, they must be certain that the correct brazing alloy is used; that the joint has penetration of alloy up the shoulder of the fitting.

That's why more and more are turning to Silbraz® joints made with Walseal valves, fittings and flanges which assure the proper amount of alloy with no waste. They know that the finished joint not only will withstand hydrostatic pressure, but it will also withstand terrific impact and vibration — in fact, no correctly made Silbraz joint has ever been known to creep or pull apart under any pressure, shock, vibration or temperature which the pipe itself can withstand.

Furthermore, it is a relatively simple operation to make a Silbraz joint — no heavy scaffolding need be erected . . . just cut the pipe, flux, assemble, then braze, following the technique recommended by the Walworth Company. A silver brazing alloy — FACTORY INSERTED — in each port flows out when heated with the oxyacetylene torch, making a joint that is stronger than the pipe itself . . . a one-hand operation, with the mechanic out of the path of the deflected heat — at all times.

For full information about Silbraz joints made with Walseal products, write for Circular A-1.

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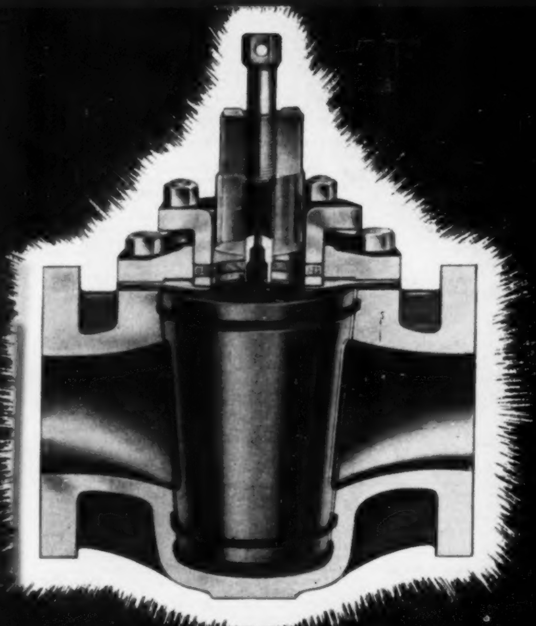

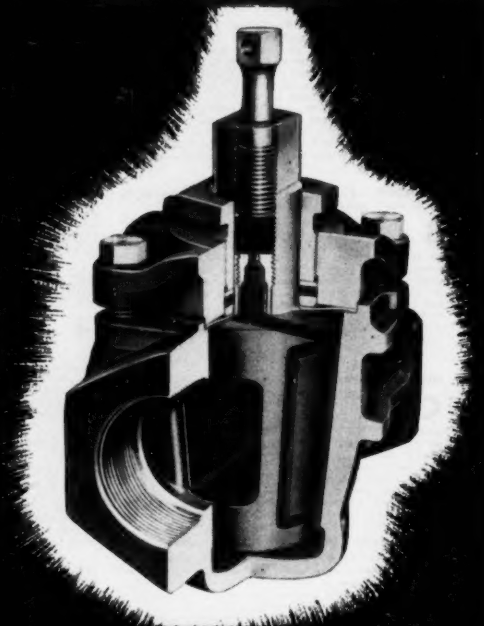

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Made in sizes from 4" and larger
in semi-steel and Nordco steel

NORDSTROM SCREWED GLAND TYPE
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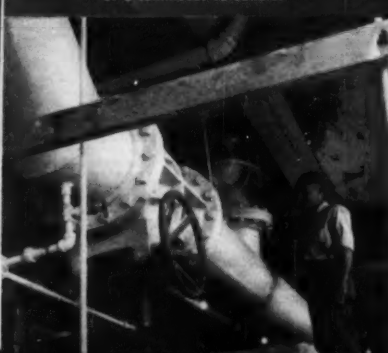
UNEXPOSED SEAT Fully protected from the line fluid, thereby avoiding corrosion and erosion

POSITIVE ROTARY ACTION Quarter-turn of tapered plug fully opens or closes

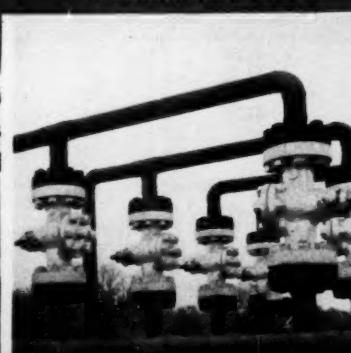
AUTOMATIC LUBRICATION Hypermatic insures constant feed and pressure

Nordstrom valves in circulating lines
of a continuous carbonator



Nordstrom gear operated valves
on fuel lines in a steam plant

Nordstrom Hypreseal valves
in a pressure reduction manifold



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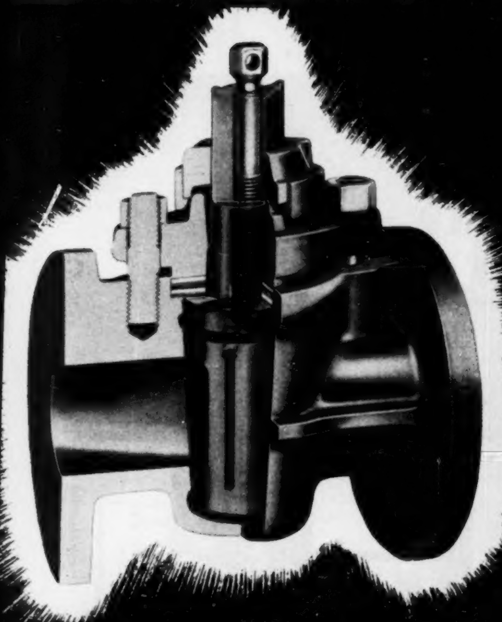

NORDSTROM 2-BOLT TYPE

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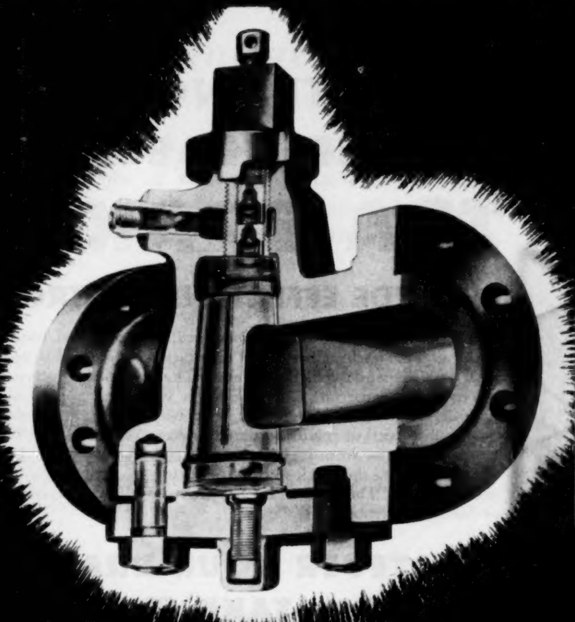

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Start replacing troublesome valves with Nordstroms

The best offense against leakage is a good defense. Bring up your present lines to top-notch condition by replacing old, troublesome valves with Nordstroms rather than trying to "patch" with valves that will again need replacement. By using Hypermatic lubricant, Nordstroms require only occasional attention, because Hypermatic gives the valves automatic lubrication.

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Nordstrom Valves

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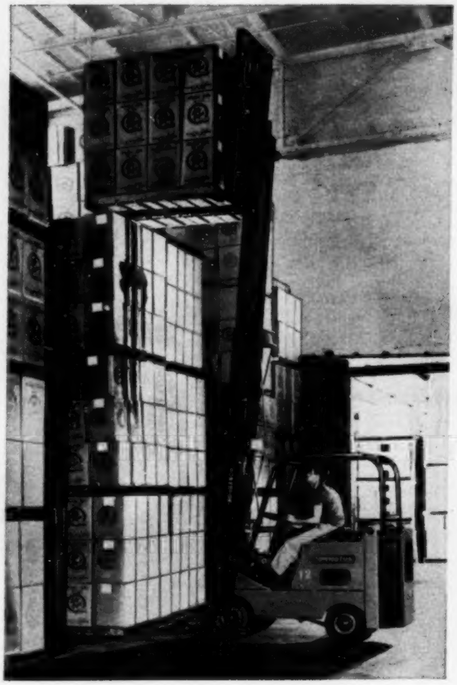
PROVIDE EFFECTIVE CONTROL!



Handling bulky loads in close quarters calls for powerful, positive braking! That's why Towmotor Corporation equips its lift trucks with safe, dependable TDA Brakes. The Towmotor industrial lift truck for materials handling has a variety of applications. It loads, transports and stores single pieces of bulky, heavy material or unit loads of small individual pieces. An extra-large TDA Brake is used for stopping, for holding the load on steep grades and for holding the truck stationary during loading and unloading operations. The TDA Brake has proved itself safe and effective under all conditions.

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June, 1951 **CARD INDEX** **Vol. 73, No. 6**

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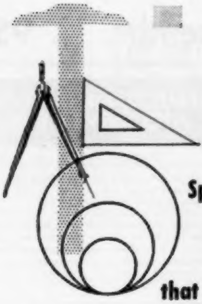

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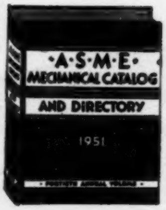

CONSULTING SERVICE . . . Page 101

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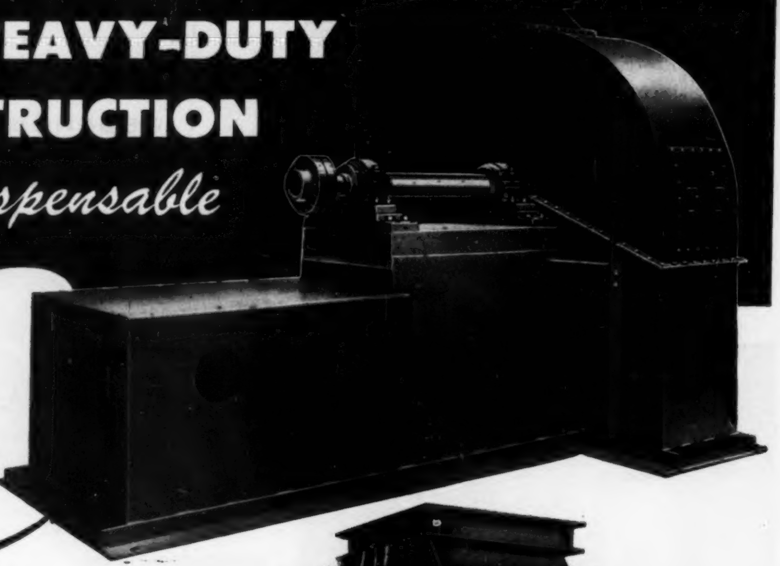

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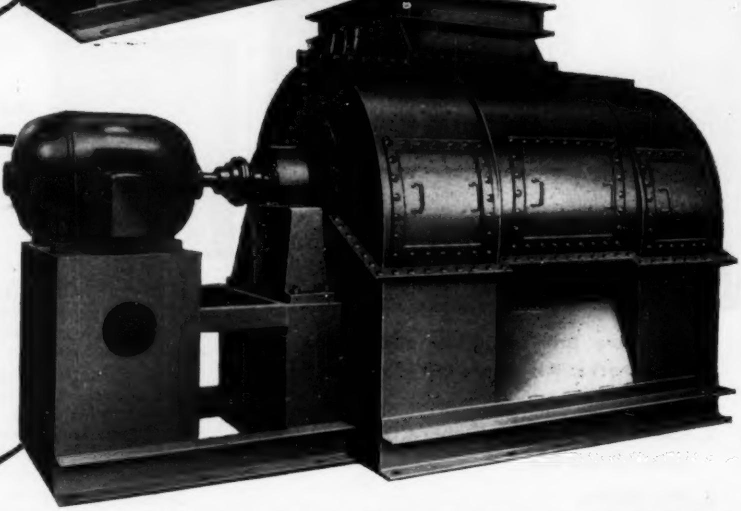

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